Nevada
Environmental
Restoration
Project

DOE/NV--1210

National Nuclear Security Administration

Corrective Action Investigation Plan for Corrective Action Unit 545: Dumps, Waste Disposal Sites, and Buried Radioactive Materials Nevada Test Site, Nevada

Controlled Copy No.: ___
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June 2007

Environmental Restoration
Project

U.S. Department of Energy
National Nuclear Security Administration
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CORRECTIVE ACTION INVESTIGATION PLAN FOR FOR CORRECTIVE ACTION UNIT 545: DUMPS, WASTE DISPOSAL SITES, AND BURIED RADIOACTIVE MATERIALS NEVADA TEST SITE, NEVADA

U.S. Department of Energy
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Las Vegas, Nevada

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Approved by: /s/ Kevin J. Cabble Date: 06/04/2007

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List of Acronyms and Abbreviations

Am	Americium
ASTM	American Society for Testing and Materials
bgs	Below ground surface
BURMA	Buried underground radioactive material area
CA	Contamination area
CAI	Corrective Action Investigation
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site
CAU	Corrective Action Unit
CERCLA	*Comprehensive Environmental Resource Conservation and Liability Act*
CFR	*Code of Federal Regulations*
COC	Contaminant of concern
COPC	Contaminant of potential concern
Cs	Cesium
CSM	Conceptual site model
DOE	U.S. Department of Energy
DOE/NV	U.S. Department of Energy, Nevada Operations Office
DOT	U.S. Department of Transportation
DQI	Data quality indicator
DQO	Data quality objective
DRO	Diesel-range organics
EPA	U.S. Environmental Protection Agency
Eu	Europium
FAL	Final action level

List of Acronyms and Abbreviations (Continued)

FFACO	*Federal Facility Agreement and Consent Order*
FOD	Field Operations Department
ft	Foot
HASL	Health and Safety Laboratory
HWAA	Hazardous waste accumulation area
IDW	Investigation-derived waste
in.	Inch
in./yr	Inch per year
ISMS	Integrated Safety Management System
kCi	Kilocurie
LCS	Laboratory control sample
LOS	Line of sight
mCi	Millicurie
MDC	Minimum detectable concentration
mi	Mile
mrem/yr	Millirem per year
MS	Matrix spike
MSD	Matrix spike duplicate
N/A	Not applicable
NAC	*Nevada Administrative Code*
NCRP	National Council on Radiation Protection and Measurement
ND	Normalized difference
NDEP	Nevada Division of Environmental Protection
NEPA	*National Environmental Policy Act*

List of Acronyms and Abbreviations *(Continued)*

NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NRS	*Nevada Revised Statutes*
NSTec	National Security Technologies, LLC
NTS	Nevada Test Site
NTSWAC	*Nevada Test Site Waste Acceptance Criteria*
NV/YMP	Nevada Yucca Mountain Project
Pa	Proactinium
PAL	Preliminary action level
PCB	Polychlorinated biphenyl
pCi/L	Picocuries per liter
POC	Performance Objective for the Certification of Nonradioactive Hazardous Waste
PPE	Personal protective equipment
ppm	Parts per million
PRG	Preliminary remediation goal
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
QC	Quality control
R/h	Roentgens per hour
RBCA	Risk-based corrective action
RCA	Radiologically controlled area
RCRA	*Resource Conservation and Recovery Act*

List of Acronyms and Abbreviations *(Continued)*

REECo	Reynolds Electrical & Engineering Co., Inc.
RL	Reporting limit
RMA	Radioactive material area
RPD	Relative percent difference
RWMS	Radioactive Waste Management Site
SNJV	Stoller-Navarro Joint Venture
Sr	Strontium
SSHASP	Site-specific health and safety plan
SSTL	Site-specific target level
SVOC	Semivolatile organic compound
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total petroleum hydrocarbons
TSCA	*Toxic Substances Control Act*
UCL	Upper confidence limit
UGTA	Underground Test Area
URMA	Underground radioactive material area
VOC	Volatile organic compound
VSP	Visual Sample Plan
yd^3	Cubic yard
μR/h	Microroentgens per hour
%R	Percent recovery

Executive Summary

Corrective Action Unit (CAU) 545 is located in Areas 2, 3, 9, and 20 of the Nevada Test Site, which is located 65 miles northwest of Las Vegas, Nevada. Corrective Action Unit 545 is comprised of the eight Corrective Action Sites (CASs) listed below:

- 02-09-01, Mud Disposal Area
- 03-08-03, Mud Disposal Site
- 03-17-01, Waste Consolidation Site 3B
- 03-23-02, Waste Disposal Site
- 03-23-05, Europium Disposal Site
- 03-99-14, Radioactive Material Disposal Area
- 09-23-02, U-9y Drilling Mud Disposal Crater
- 20-19-01, Waste Disposal Site

These sites are being investigated because existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives. Additional information will be obtained by conducting a corrective action investigation and using these data to select the appropriate corrective action for each CAS. The results of the field investigation will support a defensible evaluation of viable corrective action alternatives to be presented in the Corrective Action Decision Document.

The CASs will be investigated based on the data quality objectives (DQOs) developed on February 28, 2007, by representatives of the Nevada Division of Environmental Protection; U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office; Stoller-Navarro Joint Venture; and National Security Technologies, LLC. The DQO process was used to identify and define the data type, amount, and quality needed to develop and evaluate appropriate corrective actions for CAU 545.

Appendix A provides a detailed discussion of the DQO methodology and the DQOs specific to each CAS.

The scope of the CAU 545 corrective action investigation includes the following activities:

- Move surface debris and/or materials, as needed, to facilitate sampling.

- Conduct radiological surveys.

- Perform field screening.
- Collect and submit environmental samples for laboratory analysis to determine whether contaminants of concern are present.
- If contaminants of concern are present, collect additional step-out samples to define the extent of the contamination.
- Collect samples of investigation-derived waste, as needed, for waste management and minimization purposes.

The following CASs are not included in the scope of the field sampling activities for CAU 545:

- For CAS 03-08-03, though the potential for subsidence of the craters was judged to be extremely unlikely, the DQO meeting participants agreed that sufficient information existed about disposal and releases at the site and that a corrective action of close in place with a use restriction is recommended. Sampling in the craters will not be necessary.
- For CAS 03-23-02, there are no identified potential releases of hazardous or radioactive contaminants. Therefore, no additional information is needed to recommend a no further action corrective action alternative, and DQOs will not be developed for this CAS.
- For CAS 03-23-05, existing information about the two buried sources and lead pig is sufficient, and safety concerns exist about the stability of the crater component. Therefore, a corrective action of close in place with a use restriction is recommended, and sampling at the site will not be necessary.

This Corrective Action Investigation Plan has been developed in accordance with the *Federal Facility Agreement and Consent Order* that was agreed to by the State of Nevada, the U.S. Department of Energy, and the U.S. Department of Defense. Under the *Federal Facility Agreement and Consent Order*, this Corrective Action Investigation Plan will be submitted to the Nevada Division of Environmental Protection for approval. Fieldwork will be conducted following approval.

1.0 Introduction

This Corrective Action Investigation Plan (CAIP) contains project-specific information including facility descriptions, environmental sample collection objectives, and criteria for conducting site investigation activities at Corrective Action Unit (CAU) 545: Dumps, Waste Disposal Sites, and Buried Radioactive Materials, Nevada Test Site (NTS), Nevada.

This CAIP has been developed in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) that was agreed to by the State of Nevada, the U.S. Department of Energy (DOE), and the U.S. Department of Defense (FFACO, 1996).

Corrective Action Unit 545 is located in Areas 2, 3, 9, and 20 of the NTS, which is approximately 65 miles (mi) northwest of Las Vegas, Nevada (Figure 1-1). Corrective Action Unit 545 is comprised of the eight corrective action sites (CASs) shown on Figure 1-1 and listed below:

- 02-09-01, Mud Disposal Area
- 03-08-03, Mud Disposal Site
- 03-17-01, Waste Consolidation Site 3B
- 03-23-02, Waste Disposal Site
- 03-23-05, Europium Disposal Site
- 03-99-14, Radioactive Material Disposal Area
- 09-23-02, U-9y Drilling Mud Disposal Crater
- 20-19-01, Waste Disposal Site

The corrective action investigation (CAI) will include field inspections, radiological surveys, geophysical surveys, sampling of environmental media, analysis of samples, and assessment of investigation results, where appropriate. Data will be obtained to support corrective action alternative evaluations and waste management decisions.

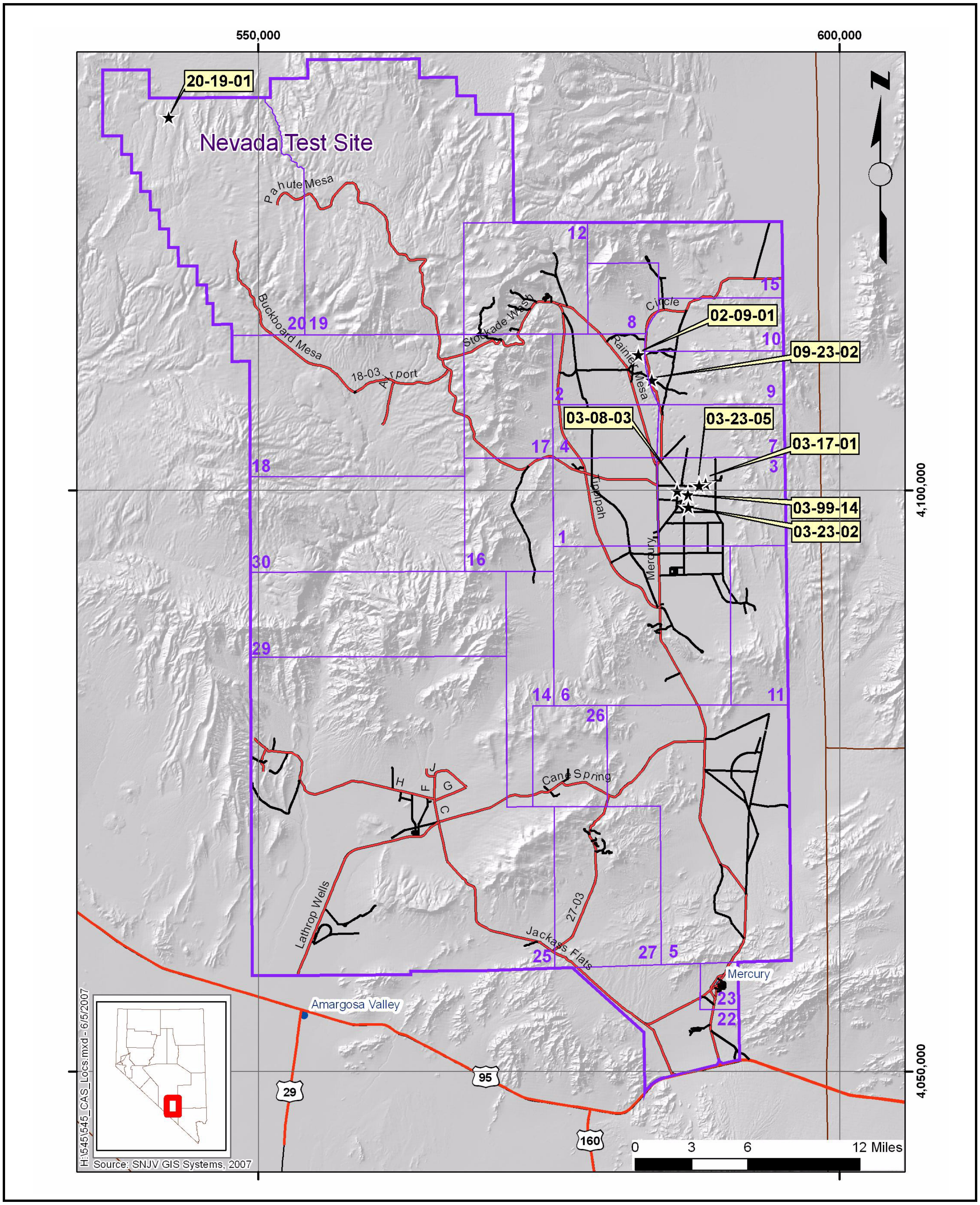

Figure 1-1
Nevada Test Site Map with CAU 545 CAS Locations

1.1 Purpose

The CASs in CAU 545 are being investigated because hazardous and/or radioactive constituents may be present in concentrations that could potentially pose a threat to human health and the environment. Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for the CASs. Additional information will be generated by conducting a CAI before evaluating and selecting corrective action alternatives.

1.1.1 Corrective Action Unit 545 History and Description

Corrective Action Unit 545, Dumps, Waste Disposal Sites, and Buried Radioactive Materials, consists of seven inactive sites located in the Yucca Flat area and one inactive site in the Pahute Mesa area. The eight CAU 545 sites consist of craters used for mud disposal, surface or buried waste disposed within craters or potential crater areas, and sites where surface or buried waste was disposed. The CAU 545 sites were used to support nuclear testing conducted in the Yucca Flat area during the 1950s through the early 1990s, and in Area 20 in the mid-1970s. Operational histories for each CAU 545 CAS are detailed in Section 2.2.

1.1.2 Data Quality Objective Summary

The sites will be investigated based on data quality objectives (DQOs) developed by representatives of the Nevada Division of Environmental Protection (NDEP); DOE, National Nuclear Security Administration Nevada Site Office (NNSA/NSO); Stoller-Navarro Joint Venture (SNJV); and National Security Technologies, LLC (NSTec). The DQOs are used to identify and define the type, amount, and quality of data needed to develop and evaluate appropriate corrective actions for CAU 545. This CAIP describes the investigative approach developed to collect the data necessary to resolve the decisions identified in the DQO process. A detailed discussion of the DQO methodology and the DQOs specific to each CAS are presented in Appendix A of this document, with a summary of the DQO process provided below.

The DQO problem statement for CAU 545 is: “Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for the CASs in CAU 545." To address this problem, the resolution of two decisions statements is required:

- Decision I: "Is any contaminant of potential concern (COPC) associated with the CAS present in environmental media at a concentration exceeding its corresponding final action level (FAL)?" For judgmental sampling, any contaminant associated with a CAS activity that is present at concentrations exceeding its corresponding FAL will be defined as a contaminant of concern (COC). For probabilistic sampling, any COPC for which the 95 percent upper confidence limit (UCL) of the mean exceeds its corresponding FAL will be defined as a COC. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2006a). If a COC is detected, then Decision II must be resolved. If a COC is not detected, the investigation for that CAS is complete.

- Decision II: "If a COC is present, is sufficient information available to evaluate potential corrective action alternatives?" Sufficient information is defined to include:

  - Identifying the lateral and vertical extent of COC contamination in media.

  - The information needed to determine potential remediation waste types.

  - The information needed to evaluate the feasibility of remediation alternatives.

The informational inputs and data needs to resolve the problem statement and the decision statements were generated as part of the DQO process for this CAU and are documented in Appendix A. The information necessary to resolve the DQO decisions will be generated for each CAU 545 CAS by collecting and analyzing samples collected during a field investigation. The presence of contamination at each CAS will be determined by collecting and analyzing samples following these two criteria:

- For judgmental sampling, samples must be collected in areas most likely to contain a COC.

- For probabilistic sampling, samples must be collected from random locations that characterize contamination within the CAS.

1.2 Scope

To generate information needed to resolve the decision statements identified in the DQO processes, the scope of the CAI for CAU 545 includes the following activities:

- Move surface debris and/or materials, as needed, to facilitate sampling.
- Conduct radiological surveys.
- Perform field screening.
- Collect and submit environmental samples for laboratory analysis to determine the nature and extent of any contamination released by each CAS.
- Collect samples of potential remediation wastes.
- Collect quality control (QC) samples.

The following CASs are not included in the scope of the field sampling activities for CAU 545:

- For CAS 03-08-03, though the potential for subsidence of the craters was judged to be extremely unlikely (LANL, date unknown), the DQO meeting participants agreed that sufficient information existed about disposal and releases at the site and that a corrective action of close in place with a use restriction is recommended. Sampling in the craters will not be necessary.
- For CAS 03-23-02, there are no identified potential releases of hazardous or radioactive contaminants. Therefore, no additional information is needed to recommend a no further action corrective action alternative, and DQOs will not be developed for this CAS.
- For CAS 03-23-05, existing information about the two buried sources and lead pig is sufficient, and safety concerns exist about the stability of the crater component. Therefore, a corrective action of close in place with a use restriction is recommended, and sampling at the site will not be necessary.

Contamination of environmental media originating from activities not identified in the conceptual site model (CSM) of any CAS will not be considered as part of this CAU unless the CSM and the DQOs are modified to include the release. If not included in the CSM, contamination originating from these sources will not be considered for sample location selection and will not be considered COCs. If such contamination is present, the contamination will be identified as part of another CAS (either new or existing).

1.3 Corrective Action Investigation Plan Contents

Section 1.0 presents the purpose and scope of this CAIP, while Section 2.0 provides background information about CAU 545. Objectives of the investigation, including CSMs, are presented in Section 3.0. Field investigation and sampling activities are discussed in Section 4.0, and waste management issues for this project are discussed in Section 5.0. General field and laboratory quality assurance (QA) (including collection of QA samples) are presented in Section 6.0 and in the Industrial Sites Quality Assurance Project Plan (QAPP) (NNSA/NV, 2002a). The project schedule and records availability are discussed in Section 7.0. Section 8.0 provides a list of references.

Appendix A provides a detailed discussion of the DQO methodology and the DQOs specific to each CAS, while Appendix B contains information on the project organization. Appendix C contains a listing of the parameters used for the initial estimate of sample size by the Visual Sample Plan (VSP) software for probabilistic sampling (PNNL, 2005), and a list of location coordinates for all randomly selected sample locations. Appendix D contains responses to NDEP comments on the draft version of this document.

2.0 Facility Description

Corrective Action Unit 545 is comprised of eight CASs that were grouped together based on their technical similarities (dumps, storage and disposal sites) and the agency responsible for closure.

The CASs are arranged into three subgroupings in the following discussions for operational history (Section 2.2), waste inventory (Section 2.3), release information (Section 2.4), and investigative background (Section 2.5). The subgroupings were made based on similar features and to facilitate discussion. The subgroupings are:

- Craters used for mud disposal purposes, located in Areas 2, 3, and 9 (CASs 02-09-01, 03-08-03, and 09-23-02)
- Surface or buried waste disposed within craters or potential crater areas, located in Areas 3 and 20 (CASs 03-23-02, 03-23-05, and 20-19-01)
- Surface or buried waste disposed at the sites, but where the physical setting is not within a crater or potential crater area, located in Area 3 (CASs 03-17-01 and 03-99-14)

2.1 Physical Setting

The following sections describe the general physical settings of Areas 2, 3, 9, and 20 of the NTS. General background information pertaining to topography, geology, hydrogeology, and climatology are provided for these specific areas of the NTS region in the *Geologic Map of the Nevada Test Site, Southern Nevada* (USGS, 1990); *CERCLA Preliminary Assessment of DOE's Nevada Operations Office Nuclear Weapons Testing Areas* (DRI, 1988); *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (ERDA, 1977); and the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996).

Geological and hydrological setting descriptions for each of the CASs are detailed in the following subsections based on the hydrogeographic area in which they are located.

2.1.1 Yucca Flat

Corrective Action Sites 02-09-01, 03-08-03, 03-17-01, 03-23-02, 03-23-05, 03-99-14, and 09-23-02 are located within the Yucca Flat Hydrographic Area of the NTS. Yucca Flat is a closed basin, which is slowly being filled with alluvial deposits eroding from the surrounding mountains (USGS, 1996).

The direction of groundwater flow in Yucca Flat generally is from the northeast to southwest. Within the overlying alluvial and volcanic aquifers, lateral groundwater flow occurs from the margins to the center of the basin and downward into the carbonate aquifer (USGS, 1996). The average annual precipitation at Station UCC on the Yucca Flat dry lake is 6.62 inches (in.) (NOAA, 2002). The recharge rate to the Yucca Flat area is relatively low (1.76 millimeters per year) and the thickness of the unsaturated zone extending to more than 600 feet (ft) below ground surface (bgs) (USGS, 1996).

Local topography within the vicinity of the CASs present in the Yucca Flat area can influence the migration of potential contaminants released from a CAS. At CAS 02-09-01, the direction of precipitation runoff flow for most of the west disposal area and portions of the south and east disposal areas is into the U-2ei crater (Figure A.2-2). The direction of precipitation runoff flow for other portions of the south and east disposal areas, however, is into gullies and washes that generally drain to the southeast. At CAS 03-08-03, all areas impacted by the release of drilling mud are either in the craters or in the drainage to the immediate northwest of the U-3ai crater that flows into the craters (Figure A.2-4). At CASs 03-17-01 and 03-23-05 (directly west of CAS 03-17-01) the direction of flow in the washes in the area is to the south and southwest (Figures A.2-14 and A.2-10, respectively). At CAS 03-23-02, the direction of flow in the washes in the area is to the south, though runoff from within the CAS is expected to be contained within the crater (Figure A.2-8). At CAS 03-99-14, the direction of flow in the washes in the area is to the south, most of which is directed into the U-3bj crater (Figure A.2-17). At CAS 09-23-02, drainage in the immediate vicinity of the crater is into the crater, except for the wash component of the CAS, which drains the crater (Figure A.2-6). The wash flows to the east and intersects a larger, unnamed south-flowing wash within several hundred feet. Ultimately, the system of washes around Yucca Flat terminate at the dry lake bed (Yucca Flat).

The nearest groundwater well to CAS 02-09-01 is Water Well U-2gg PS E3A, located 2,247 ft south of the site. The well is currently inactive, and the water is unused. The water level in this well, last measured in 1996, was 1,821 ft bgs (USGS and DOE, 2006). The nearest groundwater well to CASs 03-08-03, 03-23-02, 03-23-05, and 03-99-14 is Water Well A, which is located 3,025 ft, 4,780 ft, 8,323 ft, and 4,450 ft, respectively, of the sites. The well is currently inactive but used for observation. The water level in this well is 1,600 ft bgs (USGS and DOE, 2006). The nearest groundwater well to CAS 03-17-01 is Well U-3cn5, located 5,670 ft northwest of the site. The well is currently inactive but used for observation. The water level in this well is 1,620 ft bgs (USGS and DOE, 2006).

2.1.2 Pahute Mesa

Corrective Action Site 20-19-01 is located within the eastern part of Pahute Mesa, which is a volcanic plateau underlain by tuffs and lavas. Bedrock lies at about 0 to 10 ft bgs at the site. The CAS lies at about, 5,580 ft above mean sea level.

Local topography around the CAS is relatively flat, with gently sloping hills east and west of the site. The general direction of precipitation runoff from the site is to the east, joining a wash that generally flows to the north. Average rainfall for the area as measured by the Pahute Mesa-1 rain gauge, located approximately 7.6 mi southeast of the site and at 6,550 ft above mean sea level, measures 7.73 in. (ARL/SORD, 2006). Vegetation generally consists of brush and seasonal grasses.

The nearest groundwater well to CAS 20-19-01 is Well U-20WW2, located approximately 12,180 ft northwest of the site. The well is actively used for institutional purposes, with the most recent recorded depth to the water table at 857 ft bgs (USGS and DOE, 2006). The direction of drainage at CAS 20-19-01 is to the east and north (Figure A.2-12). The north-flowing wash ultimately terminates at the Gold Flat dry lake bed.

2.2 Operational History

The following subsections provide a description of the use and history of each CAS in CAU 545 that may have resulted in potential releases to the environment. The CAS-specific summaries are designed to describe the current definition of each CAS and illustrate all significant, known activities.

Note: The crater components of CASs 02-09-01, 03-23-02, 03-23-05, and 09-23-02 have not been determined to be safe for entry (i.e., may be unstable and therefore a safety hazard). The potential for future subsidence of the craters at CAS 03-08-03 has been judged to be extremely unlikely.

2.2.1 Group 1: CASs Associated with Mud Disposal and Craters

This grouping of sites comprises CASs 02-09-01, 03-08-03, and 09-23-02, which are primarily craters used for mud disposal purposes.

2.2.1.1 Corrective Action Site 02-09-01, Mud Disposal Area

Corrective Action Site 02-09-01 consists of mud released within and outside of the U-2ei crater, which formed as a result of the Coulommiers underground nuclear test, conducted on September 27, 1977. During underground testing activities, earthen mud pits and craters were used for the disposal of drilling mud (NNSA/NSO, 2004a). Radiologically contaminated drilling muds and decontamination waste waters were frequently taken to designated craters and disposed instead of being released to a mud pit (DOE, 1988). The specific history of mud disposal activities at the U-2ei crater is unknown; however, aerial photography indicates mud was disposed at the site between 1977 and 1984. The mud released at CAS 02-09-01 is assumed to be associated with NTS drilling operations and therefore may either be preuse material, or else used pre-test and/or post-test drilling mud. The crater area is fenced but not posted, and no stability study has been conducted at this site; thus, this crater is not considered to be safe for entry. Figure A.2-2 shows the features of CAS 02-09-01 and surrounding vicinity.

2.2.1.2 Corrective Action Site 03-08-03, Mud Disposal Site

Corrective Action Site 03-08-03 consists of mud released within the U-3ai and U-3be craters, which were formed as a result of the Hognose (March 15, 1962) and Daman I (June 21, 1962) underground nuclear tests, respectively. In 1965, the U-3ai/U-3be craters were used as a disposal site for post-test drilling mud and decontamination wastewaters, including radiologically contaminated drilling mud and possibly chromium-contaminated mud (DOE, 1988; Frazier, 1987). In 1989, the DOE, Nevada Operations Office (DOE/NV) identified the U-3ai/U-3be landfill as a location that was not in compliance with applicable federal and state laws and requested that Reynolds Electrical & Engineering Co., Inc. (REECo) immediately close the landfill (Fitzsimmons, 1989). Mud and sediment in the crater were sampled for radioactivity in 1989, and results showed no activity above background levels. In 1990, an Operations and Maintenance Plan reclassified the landfill as a Class III Construction Landfill, which restricts the disposal of materials to nonradioactive and nonhazardous drilling fluids (Elle, 1990). Although the official date of closure for the landfill is unknown, vacuum truck deliveries of waste drilling fluids are documented into 1993. Figure A.2-4 shows the features of CAS 03-08-03 and surrounding vicinity.

2.2.1.3 Corrective Action Site 09-23-02, U-9y Drilling Mud Disposal Crater

Corrective Action Site 09-23-02 consists of drilling mud disposed in and around the U-9y crater, which formed as a result of the Wichita underground nuclear test, conducted on July 27, 1962. The U-9y crater was subsequently used for the disposal of post-test drilling mud and decontamination wastewaters, including radiologically contaminated drilling mud and possibly chromium-contaminated mud, until the late 1970s (DOE, 1988; Bingham, 1992). The specific activities and operational history associated with the posted underground radioactive material area (URMA) are not known. A map from the *Nevada Test Site Contaminated Land Areas Report, Volume I,* shows that the wash adjacent to the U-9y crater was posted "Buried Radioactive Material" as of the year 2000 (DOE/NV, 2000); it is not known when the posted area became an URMA. Figure A.2-6 shows the features of CAS 09-23-02 and surrounding vicinity.

2.2.2 Group 2: CASs Associated with Waste within Crater or Potential Crater Areas

This grouping of sites comprises CASs 03-23-02, 03-23-05, and 20-19-01, which include sites where surface or buried waste was disposed within craters or potential crater areas.

2.2.2.1 Corrective Action Site 03-23-02, Waste Disposal Site

Corrective Action Site 03-23-02 consists of the U-3gi crater, which formed as a result of the Tuloso underground nuclear test, conducted on December 12, 1972. No evidence (i.e., historical documentation, aerial photography, statements, maps and engineering drawings) was identified to confirm that this site was ever used for waste storage or disposal purposes. It is believed that this site was inappropriately placed into the FFACO as a waste disposal site based on the original buried underground radioactive material area (BURMA) postings, which are suspected to have been posted based on the process knowledge that an underground nuclear test was conducted at site U-3gi.

Corrective Action Site 03-23-02 is listed as a high-risk beryllium legacy site (SAIC, 2003; BN, 2004). The document that originally identified the site as beryllium legacy site (SAIC, 2003) did not provide evidence from samples taken at the site or of operations at the site that beryllium was present. Evidence that beryllium was present at the site was also not identified in any other source reviewed during the site assessment. The Tuloso test conducted at site U-3gi is not listed as a legacy beryllium event (NNSA/NSO, 2007c), and other activities that may have contributed to the potential presence of beryllium at the site were not identified. Figure A.2-8 shows the features of CAS 03-23-02 and surrounding vicinity.

Because the site consists of an unsubsided crater, and the site has been designated as "possible" for future subsidence phenomena, sampling cannot be conducted at CAS 03-23-02 safely (LANL, date unknown).

2.2.2.2 Corrective Action Site 03-23-05, Europium Disposal Site

Corrective Action Site 03-23-05 consists of the disposal sites associated with material used in the Pommard underground nuclear test, which was conducted on March 14, 1968. Two radioactive sources, one containing europium (Eu)-152 and the other containing proactinium (Pa)-233, were used in experiments conducted during the test, with the Eu-152 source identified as being located on the third floor of a tower present at the site (REECO, 1968). The original position of the Pa-233 source during the test is not known.

Approximately one week after the Pommard test, a survey was performed on the third floor of the U-3ee tower, to determine ambient radiation levels from the Eu source. Exposure levels ranged from greater than 1,000 roentgens per hour (R/h) on the line-of-sight (LOS) pipe to 3 R/h average for the general unshielded area. On May 2, 1968, another survey was conducted on the third floor of the U-3ee tower, and on May 7 and 9, 1968, the third floor was removed and placed into a prepared burial pit approximately 50 ft from the first floor of the tower, with cement poured into the pit to reduce radiation exposure levels. On May 14 and 16, two more courses of cement were added to the Eu burial pit (inside the potential crater area) (REECo, 1968). The original amount of Eu-152 in the source is not clear. With a half-life of 13.516 years, approximately seven-eighths of the Eu-152 has decayed to gadolinium-152.

On April 4, 1968, the 40-kilocurie (kCi) Pa-233 source, sealed in a lead pig, was buried inside a fenced area, away from the potential crater area, in a strengthened "coffin" under 6 ft of grout and 2 ft of soil. After burial, the maximum exposure rate on contact with the lid was 140 microroentgens per hour (µR/h). The Pa-233 has a half-life of 26.961 days and decays to uranium (U)-233. The amount of U-233 present is estimated to be 18.7 millicuries (mCi) (Niven, 2007).

Results of a crater stability study at this site indicate that surface subsidence is possible (LANL, date unknown); therefore, the potential crater area is not considered to be safe for entry.

Figure A.2-10 shows the features of CAS 03-23-05 and surrounding vicinity.

2.2.2.3 Corrective Action Site 20-19-01, Waste Disposal Site

Corrective Action Site 20-19-01 consists of surface waste/debris believed to have been generated and disposed during testing activities at U-20p, which was the site of the Stilton underground test conducted on June 3, 1975. Several drums located at this site were removed in 1991 during housekeeping activities of CAS 20-22-03, Drums, in CAU 523. No other specific activities associated with waste disposal at CAS 20-19-01 are known. The U-20p area is fenced and posted as a potential crater area. A crater stability study at U-20p concluded that the current configuration is stable; thus, the potential crater area is considered to be safe for entry. Figure A.2-12 shows the features of CAS 20-19-01 and surrounding vicinity.

2.2.3 Group 3: CASs Associated with Surface and/or Buried Waste, Not within Craters

This grouping of sites comprises CASs 03-17-01 and 03-99-14, which are sites where surface or buried waste was disposed, but where the physical setting is not within a crater or potential crater area.

2.2.3.1 Corrective Action Site 03-17-01, Waste Consolidation Site 3B

Corrective Action Site 03-17-01 consists of the 3B Waste Consolidation Site, which was part of a program aimed at the consolidation of radioactive waste materials, such as soil and debris associated with nearby atmospheric tests. Historical documentation indicates that the site was in operation as early as 1959 and that materials stored included 42,000 cubic yards (yd^3) of soil, 200 yd^3 of concrete debris, 290 tons of steel and cable, and 5,000 board ft of lumber (REECo, 1983). Cleanup of the site, in which approximately 40,000 yd^3 of contaminated material was moved to the Area 3 Radioactive Waste Management Site (RWMS) for final disposal, began in 1986 and was completed by May 29, 1987, as part of the NTS Radioactive Waste Consolidation Project (Neagle and Horton, 1987). Aerial photography shows that by 1987, all waste was removed, and the ground surface of the rectangular and circular fenced areas were graded (EG&G/RSL, 1987). Figure A.2-14 shows the features of CAS 03-17-01 and surrounding vicinity.

2.2.3.2 Corrective Action Site 03-99-14, Radioactive Material Disposal Area

Corrective Action Site 03-99-14 consists of a soil berm and trench. The activities behind their formation are unknown. It is possible that they were formed and/or used during operations at U-3bj, which was the site of the Bandicoot underground test conducted on October 19, 1962. Aerial photographs show that the berm and trench were present as early as 1989, but the actual date of construction is unknown (EG&G/EM, 1989). It is possible that the berm is the result of excavation of the trench and that this site was not used as planned.

Corrective Action Site 03-99-14 is located within the radiological plume associated with the T3 atmospheric test site, which was the location of several atmospheric tests conducted between 1953 and 1955 that resulted in the creation of Trinity glass throughout the area (Figure A.2-19). Figure A.2-19 shows that CAS 03-99-14 is located within the 9 to 27 μR/hr contour interval and within a Trinity glass dispersion boundary. It is therefore possible to encounter elevated radioactivity at CAS 03-99-14 due to nearby atmospheric testing (Soils CAS 03-23-10). Figure A.2-17 shows the features of CAS 03-99-14 and surrounding vicinity.

2.3 Waste Inventory

Available documentation, interviews with former site employees, process knowledge, and general historical NTS practices were used to identify wastes that may be present. Historical information and site visits indicate that the sites contain wastes such as construction materials, drilling muds, equipment, a lead pig and radioactive sources, and other miscellaneous debris.

2.3.1 Group 1: CASs Associated with Mud Disposal and Craters

2.3.1.1 Corrective Action Site 02-09-01, Mud Disposal Area

The only solid waste identified for CAS 02-09-01 is drilling mud, which may be radiologically contaminated. Process knowledge gained from investigations of other drilling mud releases indicates contamination, if present, would be limited to radionuclides (NNSA/NSO, 2004a). However, the site is not posted for radiological control, and no indications of disposals of contaminated mud exist; therefore, radiological contamination is not expected at this site.

2.3.1.2 Corrective Action Site 03-08-03, Mud Disposal Site

The only solid waste identified for CAS 03-08-03 is potentially radioactive and/or chromium-contaminated drilling mud. Process knowledge gained from investigations of other drilling mud releases indicates at levels of concern, if present, would be limited to radionuclides. The site is posted with signs labeled "U3AI Uncontaminated Drilling Fluid Construction Landfill Warning This Landfill is to be Used for Uncontaminated Drilling Fluids Only Operated by REECo FOD/Drilling For Access Call 5-3651" and "Radioactive Material Area." Therefore, this site may have radioactive materials on the surface.

2.3.1.3 Corrective Action Site 09-23-02, U-9y Drilling Mud Disposal Crater

The only solid wastes identified for CAS 09-23-02 are potentially radioactive and/or chromium-contaminated drilling mud and/or buried radioactive materials. Process knowledge gained from investigations of other drilling mud releases indicates contamination, if present, would be limited to radionuclides (NNSA/NSO, 2004a). The posting of the URMA at the wash may be due to waste and debris covered by overflows of mud from the disposal crater component of CAS 09-23-02 upgradient from the wash.

2.3.2 Group 2: CASs Associated with Waste within Crater or Potential Crater Areas

2.3.2.1 Corrective Action Site 03-23-02, Waste Disposal Site

No indication exists that waste was ever stored or disposed at CAS 03-23-02. The site is posted with signs labeled "Caution Contamination Area," and the site is listed as a beryllium legacy site

(SAIC, 2003; BN, 2004). An association between the beryllium legacy site listing and site activities associated with beryllium has not been identified.

2.3.2.2 Corrective Action Site 03-23-05, Europium Disposal Site

Solid waste identified at CAS 03-23-05 consists of the buried Eu-152 source and the third floor of the tower, and the buried Pa-233 source contained within a lead pig. No other waste materials have been identified at this CAS.

2.3.2.3 Corrective Action Site 20-19-01, Waste Disposal Site

Solid waste identified at CAS 20-19-01 is comprised of wood, metal, glass, and plastic materials that are consistent with general construction debris.

2.3.3 Group 3: CASs Associated with Surface and/or Buried Waste, Not within Craters

2.3.3.1 Corrective Action Site 03-17-01, Waste Consolidation Site 3B

All solid waste was removed from CAS 03-17-01 during waste consolidation activities. Potential solid waste for CAS 03-17-01 may be buried radioactive waste comprised of either discrete, contaminated objects (e.g., metal, wood or plastic), or else soil disposed at the site, which may contain Trinity glass that formed near ground zero at atmospheric testing sites.

2.3.3.2 Corrective Action Site 03-99-14, Radioactive Material Disposal Area

While waste material has not been identified for CAS 03-99-14, the most reasonably expected waste, if any, at this site would be radiologically contaminated buried materials within the berm running the length of the site. The site is posted with signs labeled “Caution Radioactive Material”; however, atmospheric testing (Soils CAS 03-23-10) was conducted to the immediate west of the site, and all nonroad areas to the west and north of CAS 03-99-14 are likewise posted with signs labeled “Caution Radioactive Material.”

2.4 Release Information

Known or suspected releases from the CASs, including potential release mechanisms, and migration routes associated with each of the CASs are described in the following subsections. There has been no known migration of contamination at any CAU 545 CASs beyond a shallow layer of surface soil. Potentially affected media for all CASs include surface and shallow subsurface soil. Exposure routes to site workers include ingestion, inhalation, and/or dermal contact (absorption) from disturbance of contaminated soils, debris, and/or structures. Site workers may also be exposed to radiation by performing activities in proximity to radiologically contaminated materials.

At CAS 03-99-14, surface soils may have been impacted by atmospheric testing conducted to the immediate west of the site.

The following subsections contain CAS-specific descriptions of known or suspected releases associated with CAU 545.

2.4.1 Group 1: CASs Associated with Mud Disposal and Craters

2.4.1.1 Corrective Action Site 02-09-01, Mud Disposal Area

The release at CAS 02-09-01 consists of drilling mud released into the crater area, typically from a disposal vehicle.

2.4.1.2 Corrective Action Site 03-08-03, Mud Disposal Site

The release at CAS 03-08-03 consists of drilling mud released into the crater area, typically from a disposal vehicle.

2.4.1.3 Corrective Action Site 09-23-02, U-9y Drilling Mud Disposal Crater

The release at CAS 09-23-02 consists of drilling mud released into the crater area, typically from a disposal vehicle, and potentially buried radioactive waste and debris in the wash.

2.4.2 Group 2: CASs Associated with Waste within Crater or Potential Crater Areas

2.4.2.1 Corrective Action Site 03-23-02, Waste Disposal Site

There are no identified potential releases of hazardous or radioactive contaminants at CAS 03-23-02. Therefore, no additional information is needed to be able to recommend a no further action corrective action alternative, and DQOs have not been developed for this CAS.

2.4.2.2 Corrective Action Site 03-23-05, Europium Disposal Site

The release at CAS 03-23-05 consists of the buried Pa-233 and Eu-152 sources, and the lead pig, which contains the Pa-233 source.

2.4.2.3 Corrective Action Site 20-19-01, Waste Disposal Site

The release at CAS 20-19-01 consists of general construction debris, comprised of wood, metal, and glass.

2.4.3 Group 3: CASs Associated with Surface and/or Buried Waste, Not within Craters

2.4.3.1 Corrective Action Site 03-17-01, Waste Consolidation Site 3B

The release at CAS 03-17-01 consists of the former storage of potentially radioactive materials associated with various atmospheric tests.

2.4.3.2 Corrective Action Site 03-99-14, Radioactive Material Disposal Area

There is no known release at CAS 03-99-14. However, there is a potential for buried radioactive waste and debris.

2.5 Investigative Background

The following subsections summarize the investigations conducted at the CAU 545 sites. More detailed discussions of these investigations are found in Appendix A. No previous investigative results have been identified for soils or materials currently present at CASs 02-09-01, 03-23-02, 03-23-05, 03-99-14, and 09-23-02.

2.5.1 Group 1: CASs Associated with Mud Disposal and Craters

2.5.1.1 Corrective Action Site 03-08-03, Mud Disposal Site

Mud and sediment in the U-3ai/U-3be crater was sampled September 30, 1989, as part of an Environmental Survey Action Plan (DOE/NV, 1990). Samples were taken from six locations (three from each semicrater) at depths that did not exceed 4 ft bgs. The investigation appears to have been planned in 1988 for the purpose of addressing concerns that radiologically contaminated and/or chromium-contaminated drilling muds were disposed in the crater. An Environmental Survey Action Plan reports that samples were analyzed for radioactivity and results showed no activity above background levels; however, actual data for the results were not included in the report (DOE/NV, 1990). The report does not mention any chemical analysis.

2.5.2 Group 2: CASs Associated with Waste within Crater or Potential Crater Areas

2.5.2.1 Corrective Action Site 20-19-01, Waste Disposal Site

Previous corrective action activities were completed on September 9, 1991, for CAS 20-22-03, Drums, in CAU 523, at the area that includes CAS 20-19-01 (REECo, 1992). These activities involved the removal of three drums from the site, and photo-documentation to verify the drums had been removed. In the Closure Report for CAU 523, a visual verification was made that the drums were not present (NNSA/NSO, 2003). No soil samples appear to have been taken, and the remaining debris was left at the site due to inaccessibility for vehicles and worker safety. No further action was required for CAS 20-22-03.

2.5.3 Group 3: CASs Associated with Surface and/or Buried Waste, Not within Craters

2.5.3.1 Corrective Action Site 03-17-01, Waste Consolidation Site 3B

Soil at Waste Consolidation Site 3B was sampled over two time periods from 1986 to 1987, during and after cleanup activities at the site, respectively (Neagle and Horton, 1987). Details of the sampling activities, including the numerical values for the radiological analytical results, were not presented in the Waste Consolidation Plan Completion Report. Some of the first round of samples collected at the site had radiological results above ambient levels. Cleanup was completed on May 29, 1987, and the postcleanup soil sample results showed extremely low levels of activities (below 1.3 x 10^{-3} of plutonium [Pu]-239 and 1.8 x 10^{-4} of strontium [Sr]-90 per gram of soil; units for activities were not stated). Also included in the report was information about the operation of two M-102 air samplers, which did not detect alpha or gamma activities above acceptable levels during cleanup activities (Neagle and Horton, 1987).

A geophysical survey was conducted at both the rectangular and circular fenced areas of the site, for the purpose of identifying shallow subsurface geophysical anomalies during November 2006 (Weston, 2006). The survey identified 101 discrete anomalies (targets), interpreted to represent subsurface metal objects. Rodent traps found throughout the site, mostly at the surface, are possibly related to these subsurface metal objects. The central portion of the rectangular fenced area was found to contain the bulk of the anomalies, some of which may be terrain induced by the variable ground surface (i.e., soft sand, abundant desert brush, and animal burrows) (Weston, 2006). A map produced from data collected at the site is shown in Figure A.2-16.

A radiological walkover survey was conducted during September 2006 to determine whether radiological contamination was present in surface soils at concentrations statistically greater than readings from undisturbed background locations (SNJV, 2006). The survey was conducted within the rectangular fenced area. The results indicate that other than one location, which was within three times the background count rate, all other locations at the site had readings that were less than two times the background count rate (SNJV, 2006).

2.5.4 National Environmental Policy Act

The *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996) includes site investigation activities such as those proposed for CAU 545.

In accordance with the NNSA/NSO *National Environmental Policy Act* (NEPA) Compliance Program, a NEPA checklist will be completed before beginning site investigation activities at CAU 545. This checklist requires NNSA/NSO project personnel to evaluate their proposed project activities against a list of potential impacts that include, but are not limited to: air quality, chemical use, waste generation, noise level, and land use. Completion of the checklist results in a determination of the appropriate level of NEPA documentation by the NNSA/NSO NEPA Compliance Officer.

3.0 Objectives

This section presents an overview of the DQOs for CAU 545 and formulation of the CSM. Also presented is a summary listing of the contaminants reasonably suspected to be present at each CAS, (i.e., target contaminants), the COPCs, the preliminary action levels (PALs) for the investigation, and the process used to establish FALs. Additional details and figures depicting the CSM are located in Appendix A.

3.1 Conceptual Site Model

The CSM describes the most probable scenario for current conditions at each site and defines the assumptions that are the basis for identifying the future land use, contaminant sources, release mechanisms, migration pathways, exposure points, and exposure routes. The CSM is also used to support appropriate sampling strategies and data collection methods. The CSM has been developed for CAU 545 using information from the physical setting, potential contaminant sources, release information, historical background information, knowledge from similar sites, and physical and chemical properties of the potentially affected media and COPCs. Figure 3-1 depicts a tabular representation of the conceptual pathways to receptors from CAU 545 sources. Figure 3-2 depicts a graphical representation of the CSM. If evidence of contamination that is not consistent with the presented CSM is identified during investigation activities, the situation will be reviewed, the CSM will be revised, the DQOs will be reassessed, and a recommendation will be made as to how best to proceed. In such cases, decision makers listed in Section A.3.1 will be notified and given the opportunity to comment on and/or concur with the recommendation.

The following sections discuss future land use and the identification of exposure pathways (i.e., combination of source, release, migration, exposure point, and receptor exposure route) for the CAU.

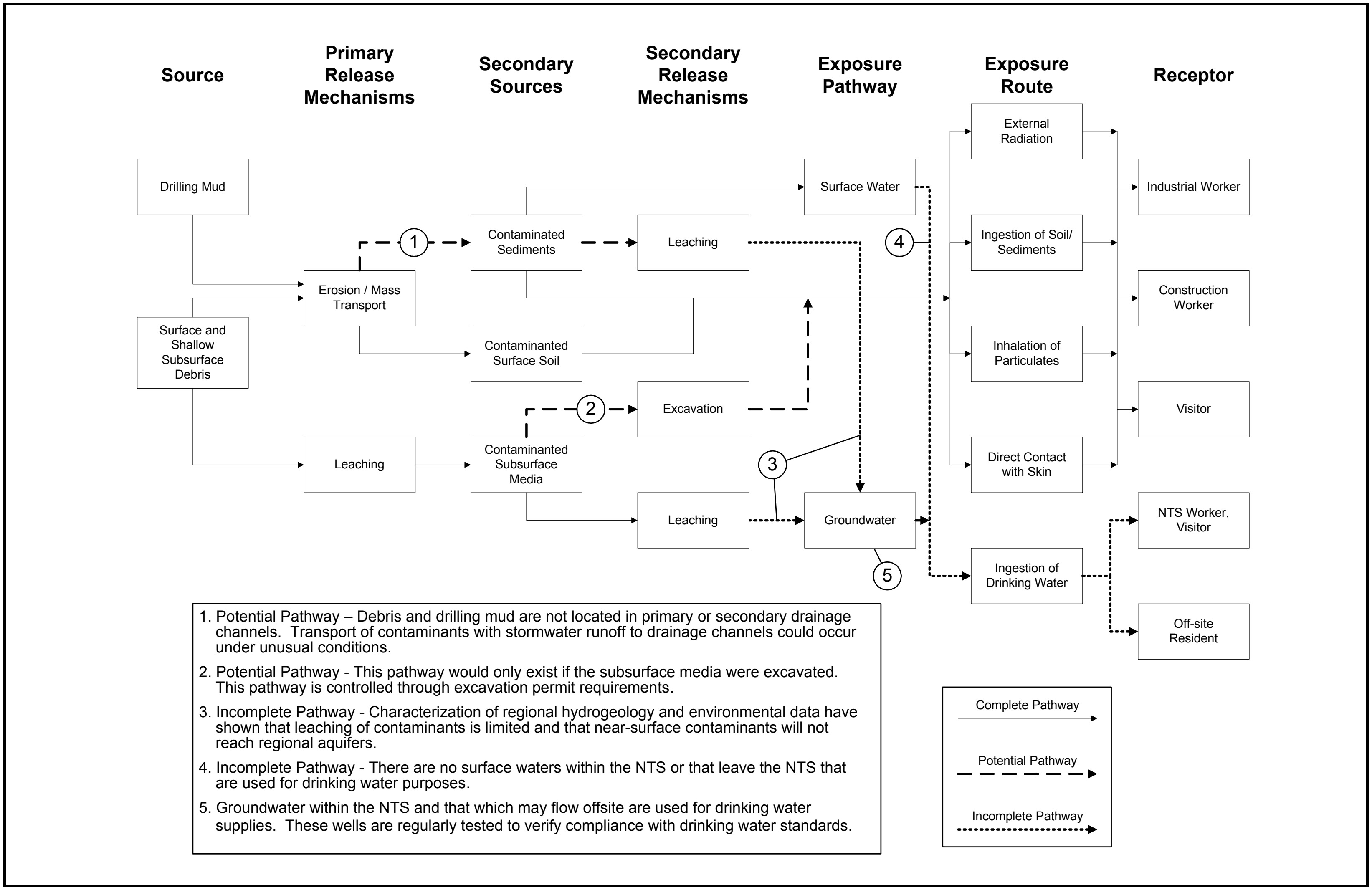

Figure 3-1
Conceptual Site Model Diagram

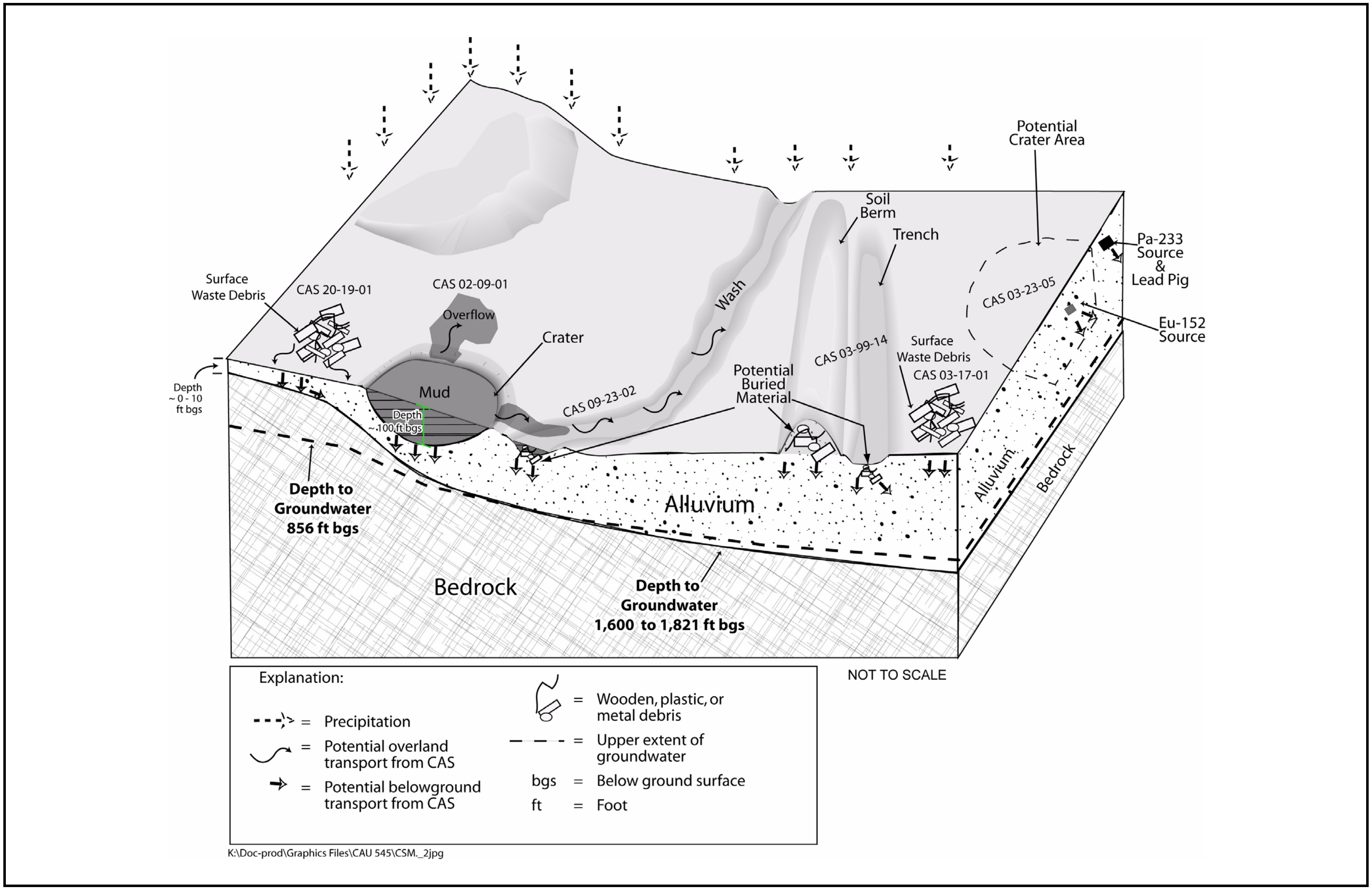

Figure 3-2
Corrective Action Unit 545 Conceptual Site Model

3.1.1 Land-Use and Exposure Scenarios

Corrective Action Sites 02-09-01, 03-08-03, 03-17-01, 03-23-05, and 03-99-14 are located in the land-use zone described as the “Nuclear and High Explosives Test Zone.” This area is designated within the Nuclear Test Zone for additional underground nuclear weapons tests and outdoor high-explosive tests. This zone includes compatible defense and nondefense research, development, and testing activities (DOE/NV, 1998).

Corrective Action Sites 09-23-02 and 20-19-01 are located in the land-use zone described as the “Nuclear Test Zone.” This area is reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons effects tests. This zone includes compatible defense and nondefense research, development, and testing activities (DOE/NV, 1998).

All land-use zones where the CAU 545 CASs are located dictate future land use, and restrict current and future land use to nonresidential (i.e., industrial) activities.

The exposure scenario applicable to all CAU 545 CASs is the Occasional Use Area. This exposure scenario assumes exposure to industrial workers who are not assigned to the area as a regular worksite but may occasionally use the site for intermittent or short-term activities. A site worker under this scenario is assumed to be on the site for an equivalent of 8 hours per day, 10 days per year, for 5 years.

3.1.2 Contaminant Sources

The potential contamination sources for the CAU 545 CSM are:

- Drilling mud disposed in and near craters at CASs 02-09-01, 03-08-03, and 09-23-02
- Waste and debris stored onto the surface at CASs 03-17-01 and 20-19-01
- Waste and debris buried at CASs 03-23-05, 03-99-14, and 09-23-02

3.1.3 Release Mechanisms

Release mechanisms for the CSM are spills and leaks onto surface soils from items such as drilling muds or equipment; or from processes such as dumping from mud trucks onto the surface, dumping of debris onto the surface, or erosion onto the surface from formerly stored materials. Buried materials may have leaked or been spilled.

3.1.4 Migration Pathways

Migration pathways include the lateral migration of potential contaminants across surface soils/sediments and vertical migration of potential contaminants through subsurface soils.

Migration is influenced by physical and chemical characteristics of the contaminants and media. Contaminant characteristics include, but are not limited to: solubility, density, and adsorption potential. Media characteristics include permeability, porosity, water saturation, sorting, chemical composition, and organic content. In general, contaminants with low solubility, high affinity for media, and high density can be expected to be found relatively close to release points. Contaminants with high solubility, low affinity for media, and low density can be expected to be found further from release points. These factors affect the migration pathways and potential exposure points for the contaminants in the various media under consideration.

Infiltration and percolation of precipitation serves as a driving force for downward migration of contaminants. However, due to high potential evapotranspiration (annual potential evapotranspiration at the Area 3 RWMS has been estimated at 62.6 in. (Shott et al., 1997) and limited precipitation for this region (from 6.4 inches per year [in./yr] at the Buster Jangle rain gauge to 7.73 in./yr at the Pahute Mesa 1 rain gauge), percolation of infiltrated precipitation at the NTS does not provide a significant mechanism for vertical migration of contaminants to groundwater (ARL/SORD, 2006).

Contaminants released into a wash leaving the site of release are subject to much higher transport mechanisms than contaminants released to other surface areas. The wash leaving CAS 09-23-02 is generally dry but is subject to infrequent, potentially intense, stormwater flows. These stormwater flow events provide an intermittent mechanism for both vertical and horizontal transport of contaminants. Contaminated sediments entrained by these stormwater events would be carried by the streamflow to locations where the flowing water loses energy and the sediments drop out. These locations are readily identified as sedimentation areas. Other CASs either do not have prominent washes within the site, or else the most definable wash flows into the crater (e.g., the wash entering the craters at CAS 03-08-03 from the north).

Subsurface migration pathways at all CASs are expected to be predominately vertical, although spills or leaks at the ground surface may also have limited lateral migration before infiltration. The depth of infiltration (shape of the subsurface contaminant plume) will be dependant upon the type, volume, and duration of the discharge as well as the presence of relatively impermeable layers that could modify vertical or horizontal transport pathways, both on the ground surface (e.g., concrete) and in the subsurface (e.g., caliche layers).

3.1.5 Exposure Points

Exposure points for the CAU 545 CSM are expected to be areas of surface contamination where visitors and site workers will come in contact with soil surface. Subsurface exposure points may also exist if construction workers come in contact with contaminated media during excavation activities.

3.1.6 Exposure Routes

Exposure routes to site workers include ingestion, inhalation, and/or dermal contact (absorption) from disturbance of, or direct contact with, contaminated media. Site workers may also be exposed to radiological contamination by performing activities in proximity to radiologically contaminated materials.

3.1.7 Additional Information

Information concerning topography, geology, climatic conditions, hydrogeology, floodplains, and infrastructure at the CAU 545 CASs are available and are presented in Section 2.1 as they pertain to the investigation. This information has been addressed in the CSM and will be considered during the evaluation of corrective action alternatives, as applicable. Climatic and site conditions (e.g., surface and subsurface soil descriptions) will be recorded during the CAI.

3.2 Contaminants of Potential Concern

The COPCs for CAU 545 are defined as the list of constituents represented by the analytical methods identified in Table 3-1 for Decision I environmental samples taken at each of the CASs. The constituents reported for each analytical method are listed in Table 3-2.

Table 3-1
Analytical Program[a]
(Includes Waste Characterization Analyses)

Analyses	CAS 02-09-01	CAS 03-17-01	CAS 03-99-14	CAS 09-23-02	CAS 20-19-01
Organic Contaminants of Potential Concern (COPCs)					
Total Petroleum Hydrocarbons-Diesel-Range Organics	--	--	X	X	X
Polychlorinated Biphenyls	--	--	X	--	X
Semivolatile Organic Compounds	--	--	X	X	X
Volatile Organic Compounds	--	--	X	X	X
Inorganic COPCs					
Resource Conservation and Recovery Act Metals	--	X	X	X	X
Radionuclide COPCs					
Gamma Spectroscopy[b]	X	X	X	X	X
Isotopic Uranium	X	X	X	X	X
Isotopic Plutonium	X	X	X	X	X
Strontium-90	X	X	X	X	X

X = Required analytical method

[a]The contaminants of potential concern are the constituents reported from the analytical methods listed.
[b]Results of gamma analysis will be used to determine whether further radioanalytical analysis is warranted.

Table 3-2
Constituents Reported by Analytical Methods

VOCs	VOCs	SVOCs	SVOCs	TPH	PCBs	Metals	Isotopic Radionuclides
1,1,1-Trichloroethane	Chloroprene	2,3,4,6-Tetrachlorophenol	Dimethylpthalate	TPH-DRO (Diesel-Range Organics)	Aroclor 1016	Arsenic	Plutonium-238
1,1,1,2-Tetrachloroethane	Dibromochloromethane	2,4-Dimethylphenol	Di-n-butylpthalate		Aroclor 1221	Barium	Plutonium-239/240
1,1,2,2-Tetrachloroethane	Dichlorodifluoromethane	2,4-Dinitrotoluene	Di-n-octyl Phthalate		Aroclor 1232	Cadmium	Strontium-90
1,1,2-Trichloroethane	Ethyl methacrylate	2,4,5-Trichlorophenol	Fluoranthene		Aroclor 1242	Chromium	Uranium-234
1,1-Dichloroethane	Ethylbenzene	2,4,6-Trichlorophenol	Fluorene		Aroclor 1248	Lead	Uranium-235
1,1-Dichloroethene	Isobutyl alcohol	2-Chlorophenol	Hexachlorobenzene		Aroclor 1254	Mercury	Uranium-238
cis-1,2-Dichloroethene	Isopropylbenzene	2-Methylnaphthalene	Hexachlorobutadiene[a]		Aroclor 1260	Selenium	Tritium
1,2-Dichloroethane	m-Dichlorobenzene (1,3)	2-Methylphenol	Hexachloroethane		Aroclor 1268	Silver	**Gamma-emitting Radionuclides**
1,2-Dichloropropane	Methacrylonitrile	2-Nitrophenol	Indeno(1,2,3-cd)pyrene				Actinium-228
1,2,4-Trichlorobenzene	Methyl methacrylate	3-Methylphenol[b]	Naphthalene[a]				Americium-241
1,2,4-Trimethylbenzene	Methylene chloride	4-Chloroaniline	Nitrobenzene				Cobalt-60
1,2-Dibromo-3-chloropropane	N-Butylbenzene	4-Methylphenol[b]	N-Nitroso-di-n-propylamine				Cesium-137
1,3,5-Trimethylbenzene	N-Propylbenzene	4-Nitrophenol	Pentachlorophenol				Europium-152
1,4-Dioxane	o-Dichlorobenzene (1,2)	Acenaphthene	Phenanthrene				Europium-154
2-Butanone	p-Dichlorobenzene (1,4)	Acenaphthylene	Phenol				Europium-155
2-Chlorotoluene	p-isopropyltoluene	Aniline	Pyrene				Potassium-40
2-Hexanone	sec-Butylbenzene	Anthracene	Pyridine				Niobium-94
4-Methyl-2-pentanone	Styrene	Benzo(a)anthracene					Lead-212
Acetone	tert-Butylbenzene	Benzo(a)pyrene					Lead-214
Acetonitrile	Tetrachloroethene	Benzo(b)fluoranthene					Thorium-234
Allyl chloride	Toluene	Benzo(g,h,i)perylene					Thallium-208
Benzene	Total Xylenes	Benzo(k)fluoranthene					Uranium-235
Bromodichloromethane	Trichloroethene	Benzoic Acid					
Bromoform	Trichlorofluoromethane	Benzyl Alcohol					
Bromomethane	Vinyl acetate	Bis(2-ethylhexyl) phthalate					
Carbon disulfide	Vinyl chloride	Butyl benzyl phthalate					
Carbon tetrachloride		Carbazole					
Chlorobenzene		Chrysene					
Chloroethane		Dibenzo(a,h)anthracene					
Chloroform		Dibenzofuran					
Chloromethane		Diethyl Phthalate					

[a]May be reported with VOCs
[b]May be reported as 3,4-methylpenol

PCB = Polychlorinated biphenyl
SVOC = Semivolatile organic compound

TPH = Total petroleum hydrocarbons
VOC = Volatile organic compound

The list of COPCs is intended to encompass all of the contaminants that could potentially be present at each CAS. These COPCs were identified during the planning process through the review of site history, process knowledge, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs. Contaminants detected at other similar NTS sites were also included in the COPC list to reduce the uncertainty about potential contamination at the CASs because complete information regarding activities performed at the CAU 545 sites is not available.

During the review of site history documentation, process knowledge information, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs, some of the COPCs were identified as targeted contaminants at specific CASs. Targeted contaminants are those COPCs for which evidence in the available site and process information suggests that they may be reasonably suspected to be present at a given CAS. The targeted contaminants are required to meet a more stringent completeness criteria than other COPCs thus providing greater protection against a decision error (see Sections A.1.0 through A.7.0). Targeted contaminants for each CAU 545 CAS are identified in Table 3-3.

Table 3-3
Targeted Contaminants for CAU 545

Corrective Action Site	Chemical Targeted Contaminant(s)	Radiological Targeted Contaminant(s)
02-09-01	--	--
03-17-01	--	Am-241, Cs-137, Eu-152, and Isotopic Pu
03-99-14	--	--
09-23-02	--	Am-241, Cs-137, and Isotopic Pu
20-19-01	--	--

Am = Americium
Cs = Cesium
Eu = Europium
Pu = Plutonium

The radionuclides americium (Am)-241, cesium (Cs)-137, Eu-152, Pu-238, and Pu-239 are targeted analytes for CAS 03-17-01 due to the occurrence of radionuclides at similar sites (CASs 01-08-01 and 07-23-02 for CAU 137; CAS 04-08-02 for CAU 139) or else their expected presence in radiologically contaminated waste and debris from atmospheric testing sites (NNSA/NSO, 2007a and b). The radionuclides U-233 (progeny from Pa-233 radioactive decay) and Eu-152, both present as radioactive sources, and the RCRA metal lead, present as the lead pig, are targeted analytes for CAS 03-23-05. The radionuclides Am-241, Cs-137, Pu-238, and Pu-239 are targeted analytes for CAS 09-23-02 due to the posting of the wash component as an URMA. The radionuclide Eu-152 is not targeted for this CAS because no evidence exists that material in the wash came from near ground zero at an atmospheric testing site.

3.3 Preliminary Action Levels

The PALs presented in this section are to be used for site screening purposes. They are not necessarily intended to be used as cleanup action levels or FALs. However, they are useful in screening out contaminants that are not present in sufficient concentrations to warrant further evaluation, therefore streamlining the consideration of remedial alternatives. The risk-based corrective action (RBCA) process used to establish FALs is described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006a). This process conforms with *Nevada Administrative Code* (NAC) Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2006c). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2006d) requires the use of American Society for Testing and Materials (ASTM) Method E 1739-95 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (i.e., FALs) or to establish that corrective action is not necessary."

This RBCA process, summarized in Figure 3-3, defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses:

- Tier 1 evaluation – Sample results from source areas (highest concentrations) are compared to action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the CAIP). The FALs may then be established as the Tier 1 action levels or the FALs may be calculated using a Tier 2 evaluation.

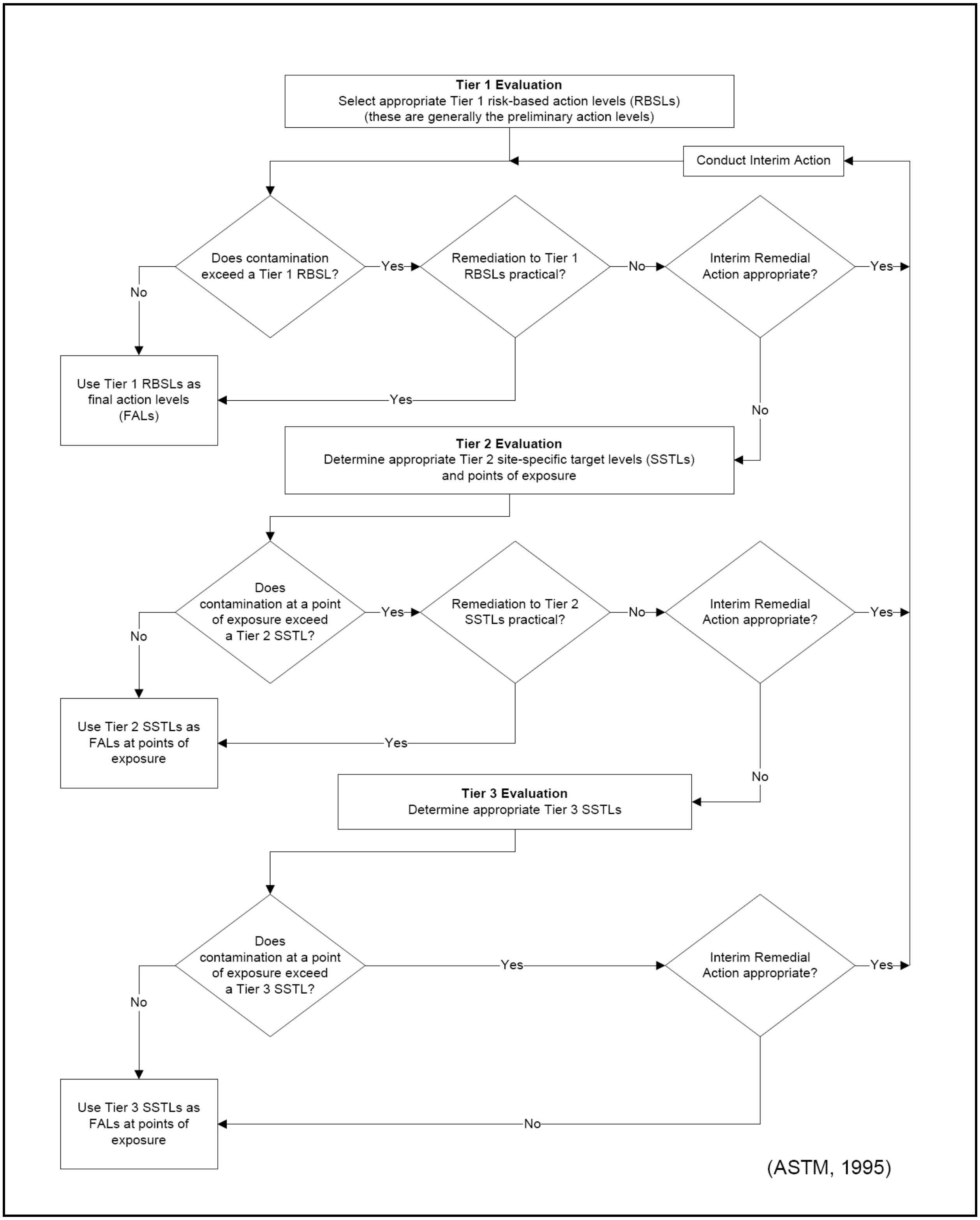

Figure 3-3
Risk-Based Corrective Action Decision Process

- Tier 2 evaluation – Conducted by calculating Tier 2 site-specific target levels (SSTLs) using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 SSTLs are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. Total concentrations of total petroleum hydrocarbons (TPH) will not be used for risk-based decisions under Tier 2 or Tier 3. Rather, the individual chemicals of concern will be compared to the SSTLs.

- Tier 3 evaluation – Conducted by calculating Tier 3 SSTLs on the basis of more sophisticated risk analyses using methodologies described in ASTM Method E 1739-95 that consider site-, pathway-, and receptor-specific parameters.

This process includes a provision for conducting an interim remedial action if necessary and appropriate. The decision to conduct an interim action may be made at any time during the investigation and at any level (tier) of analysis. Concurrence of the decision makers listed in Section A.3.1 will be obtained before any interim action is implemented. Evaluation of DQO decisions will be based on conditions at the site following completion of any interim actions. Interim actions conducted will be included in the investigation report.

The FALs (along with the basis for their selection) will be proposed in the investigation report, where they will be compared to laboratory results in the evaluation of potential corrective actions.

3.3.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the U.S. Environmental Protection Agency (EPA) *Region 9 Risk-Based Preliminary Remediation Goals (PRGs)* for contaminant constituents in industrial soils (EPA, 2004b). Background concentrations for RCRA metals will be used instead of PRGs when natural background concentrations exceed the PRG, as is often the case with arsenic on the NTS. Background is considered the mean plus two standard deviations of the mean for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999). For detected chemical COPCs without established PRGs, the protocol used by the EPA Region 9 in establishing PRGs (or similar) will be used to establish PALs. If used, this process will be documented in the investigation report.

3.3.2 Total Petroleum Hydrocarbons PALs

The PAL for TPH is 100 parts per million (ppm) as listed in NAC 445A.2272 (NAC, 2006e).

3.3.3 Radionuclide PALs

The PALs for radiological contaminants (other than tritium) are based on the National Council on Radiation Protection and Measurement (NCRP) Report No. 129 recommended screening limits for construction, commercial, industrial land-use scenarios (NCRP, 1999) using a 25 millirem per year (mrem/yr) dose constraint (Murphy, 2004) and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993). These PALs are based on the construction, commercial, and industrial land-use scenario provided in the guidance and are appropriate for the NTS based on future land-use scenarios as presented in Section 3.1.1.

The PAL for tritium is based on the Underground Test Area (UGTA) Project limit of 400,000 picocuries per liter (pCi/L) for discharge of water containing tritium (NNSA/NV, 2002b). The activity of tritium in the soil moisture of soil samples will be reported in units of pCi/L for comparison to this PAL.

Solid media such as concrete and/or structures may pose a potential radiological exposure risk to site workers if contaminated. The radiological PAL for solid media will be defined as the unrestricted-release criteria defined in the *NV/YMP Radiological Control* (RadCon) *Manual* (NNSA/NSO, 2004b).

3.4 Data Quality Objective Process Discussion

This section contains a summary of the DQO process that is presented in Appendix A. The DQO process is a strategic planning approach based on the scientific method that is designed to ensure that the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend the recommendation of viable corrective actions (e.g., no further action, clean closure, or closure in place).

The DQO strategy for CAU 545 was developed at a meeting on February 28, 2007. The DQOs were developed to identify data needs, clearly define the intended use of the environmental data, and to design a data collection program that will satisfy these purposes. During the DQO discussions for this CAU, the informational inputs or data needs to resolve problem statements and decision statements were documented.

The problem statement for CAU 545 is: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for the CASs in CAU 545." To address this question, the resolution of two decisions statements is required:

- Decision I: "Is any COC present in environmental media within the CAS?" If a COC is detected, then Decision II must be resolved. Otherwise, the investigation for that CAS is complete.
- Decision II: "If a COC is present, is sufficient information available to evaluate potential corrective action alternatives?" Sufficient information is defined to include:
    - Identifying the volume of media containing any COC bounded by analytical sample results in lateral and vertical directions.
    - The information needed to determine potential remediation waste types.
    - The information needed to evaluate the feasibility of remediation alternatives (geotechnical data if construction or evaluation of barriers is considered).

The presence of a COC would require a corrective action. A corrective action may also be necessary if there is a potential for wastes that are present at a site to impose COCs into site environmental media if the wastes were to be released. To evaluate the potential for a future release from source material introducing a COC to the surrounding environmental media, the following conservative assumptions were made:

- The grout surrounding the buried lead pig and Pa-233 would fail at some point, and lead and radionuclides would be released to the surrounding media.
- Waste or debris containing materials that are comprised of contaminants (e.g., lead batteries, fluorescent light bulbs and ballasts, floor tiles, preserved wood) would decompose at some point and release the contaminant(s) to the surrounding media.
- The resulting concentration of contaminants in the surrounding media would be significantly greater than applicable action levels.

Decision I samples will be submitted to analytical laboratories for the analyses listed in Table 3-1. Decision II samples will be submitted for the analysis of all unbounded COCs. In addition, samples will be submitted for analyses as needed to support waste management or health and safety decisions.

The data quality indicators (DQIs) of precision, accuracy, representativeness, completeness, comparability, and sensitivity needed to satisfy DQO requirements are discussed in Section 6.2. Laboratory data will be assessed in the investigation report to confirm or refute the CSM and determine whether the DQO data needs were met.

To satisfy the DQI of sensitivity (presented in Section 6.2.8), the analytical methods must be sufficient to detect contamination that is present in the samples at concentrations less than or equal to the corresponding FALs. Analytical methods and target minimum detectable concentrations (MDCs) for each CAU 545 COPC are provided in Tables 3-4 and 3-5. The MDC is the lowest concentration of a chemical or radionuclide parameter that can be detected in a sample within an acceptable level of error. Due to changes in analytical methodology and changes in analytical laboratory contracts, information in Tables 3-4 and 3-5 that varies from corresponding information in the QAPP will supersede that information in the QAPP (NNSA/NV, 2002a).

Table 3-4
Analytical Requirements for Radionuclides for CAU 545

Constituent	Medium or Matrix	Analytical Method	Minimum Detectable Concentration (MDC)[a]	Laboratory Precision	Laboratory Accuracy (%R)
Gamma-Emitting Radionuclides					
Gamma Spectroscopy	Aqueous	EPA 901.1[b]	< Preliminary Action Levels	RPD 35%[c] ND[d] -2<ND[d]<2	Laboratory Control Sample 80-120%R
	Solid	HASL-300[e]			
Other Radionuclides					
Tritium	Aqueous	EPA 906.0[b]	< Preliminary Action Levels	RPD 35%[f] ND[d] -2<ND[d]<2	Laboratory Control Sample 80-120%R Chemical Yield 30-105%R (not applicable for tritium and gross-alpha/beta) Matrix Spike Sample 61-140%R (tritium and gross alpha/beta only)
	Solid	Approved Laboratory Procedure[c]			
Gross-alpha	Aqueous	EPA 900.0[b]			
	Solid				
Gross-beta	Aqueous	EPA 900.0[b]			
	Solid				
Plutonium-238	Aqueous	HASL-300[e]			
	Solid				
Plutonium-239/240	Aqueous	HASL-300[e]			
	Solid				
Strontium-90	Aqueous	HASL-300[e]			
	Solid				
Uranium-234	Aqueous	HASL-300[e]			
	Solid				
Uranium-235	Aqueous	HASL-300[e]			
	Solid				
Uranium-238	Aqueous	HASL-300[e]			
	Solid				

[a]The MDC is the lowest concentration of a radionuclide present in a sample and can be detected with a 95% confidence level.
[b]*Prescribed Procedures for Measurement of Radioactivity in Drinking Water (*EPA, 1980)
[c]Laboratory procedure must be approved by appropriate project personnel.
[d]ND is not RPD; rather, it is another measure of precision used to evaluate duplicate analyses. The ND is calculated as the difference between two results divided by the square root of the sum of the squares of their total propagated uncertainties. *Evaluation of Radiochemical Data Usability* (DOE, 1997a)
[e]*The Procedures Manual of the Environmental Measurements Laboratory*, HASL-300 (DOE, 1997b)
[f]*Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) with Guidance* (EPA, 2000)

EPA = U.S. Environmental Protection Agency
HASL = Health and Safety Laboratory
ND = Normalized difference
RPD = Relative percent difference
%R = Percent recovery

Table 3-5
Analytical Requirements for Chemical COPCs for CAU 545
(Page 1 of 2)

Analysis[a]	Matrix	Analytical Method (SW-846)[b]	Minimum Detectable Concentration (MDC)[c]	Laboratory Precision	Laboratory Accuracy (%R)
ORGANICS					
Total Volatile Organic Compounds	Aqueous	8260B	< Preliminary Action Levels	Lab-specific[d]	Lab-specific[d]
	Solid				
TCLP Volatile Organic Compounds	Aqueous	1311/8260B	≤ Regulatory Limits	Lab-specific[d]	Lab-specific[d]
Total Semivolatile Organic Compounds	Aqueous	8270C	< Preliminary Action Levels	Lab-specific[d]	Lab-specific[d]
	Solid				
TCLP Semivolatile Organic Compounds	Aqueous	1311/8270C	≤ Regulatory Limits	Lab-specific[d]	Lab-specific[d]
Polychlorinated Biphenyls	Aqueous	8082	< Preliminary Action Levels	Lab-specific[d]	Lab-specific[d]
	Solid				
Total Petroleum Hydrocarbons-Gasoline-Range Organics	Aqueous	8015B (modified)		Lab-specific[d]	Lab-specific[d]
	Solid				
Total Petroleum Hydrocarbons-Diesel-Range Organics	Aqueous	8015B (modified)		Lab-specific[d]	Lab-specific[d]
	Solid				
Pesticides	Aqueous	8081A		Lab-specific[d]	Lab-specific[d]
	Solid				
TCLP Pesticides	Aqueous	1311/8081A	≤ Regulatory Limits	Lab-specific[d]	Lab-specific[d]
Herbicides	Aqueous	8151A	< Preliminary Action Levels	Lab-specific[d]	Lab-specific[d]
	Solid				
TCLP Herbicides	Aqueous	1311/8151A	≤ Regulatory Limits	Lab-specific[d]	Lab-specific[d]
Explosives	Aqueous	8330	< Preliminary Action Levels	Lab-specific[d]	Lab-specific[d]
	Solid				
INORGANICS					
Metals	Aqueous	6010B	< Preliminary Action Levels	RPD 35% (solid)[e] 20% (aqueous)[e] Absolute Difference[f] ±2x RL (solid)[f] ±1x RL (aqueous)[f]	Matrix Spike Sample 75-125%R[b] Laboratory Control Sample 80-120%R[f]
	Solid				
Mercury	Aqueous	7470A			
	Solid	7471A			
TCLP Metals	Aqueous	1311/6010B	≤ Regulatory Limits		
TCLP Mercury	Aqueous	7470A			

Table 3-5
Analytical Requirements for Chemical COPCs for CAU 545
(Page 2 of 2)

Analysis[a]	Matrix	Analytical Method (SW-846)[b]	Minimum Detectable Concentration (MDC)[c]	Laboratory Precision	Laboratory Accuracy (%R)

[a]Applicable constituents are listed in Table 3-2.
[b]*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846) (EPA, 1996)
[c]The MDC is the lowest concentration that can be reliably achieved within specified limits of accuracy and precision.
[d]RPD and %R performance criteria are developed by the analytical laboratory according to approved procedures.
[e]*Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) with Guidance* (EPA, 2000)
[f]*USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2004a)

$<$ = Less than
$\leq$ = Less than or equal to
$\pm$ = Plus or minus
RL = Reporting limit
RPD = Relative percent difference
TCLP = Toxicity Characteristic Leaching Procedure
%R = Percent recovery

4.0 Field Investigation

This section contains a description of the activities to be conducted to gather and document information from the CAU 545 field investigation.

4.1 Technical Approach

The information necessary to satisfy the DQO data needs will be generated for each CAU 545 CAS by collecting and analyzing samples generated during a field investigation. The presence and nature of contamination at CASs 02-09-01, 03-99-14, 09-23-02, and 20-19-01 will be evaluated using a judgmental approach.

The presence and nature of contamination at CAS 03-17-01 will be evaluated using a probabilistic approach because biasing factors and site information are not sufficient to adequately focus the investigation on specific locations.

The following CASs are not included in the scope of the field sampling activities for CAU 545:

- For CAS 03-08-03, though the potential for subsidence of the craters was judged to be extremely unlikely, the DQO meeting participants agreed that sufficient information existed about disposal and releases at the site and that a corrective action of close in place with a use restriction is recommended. Sampling in the craters will not be necessary.

- For CAS 03-23-02, there are no identified potential releases of hazardous or radioactive contaminants. Therefore, no additional information is needed to recommend a no further action corrective action alternative, and DQOs will not be developed for this CAS.

- For CAS 03-23-05, existing information about the two buried sources and lead pig is sufficient, and safety concerns exist about the stability of the crater component. Therefore, a corrective action of close in place with a use restriction is recommended, and sampling at the site will not be necessary.

- Additionally, the crater components of CASs 02-09-01 and 09-23-02 are not included in the scope of the field sampling activities. These have not been determined to be safe for entry (i.e., may be unstable, and therefore a safety hazard).

If there is a waste present, at CASs and CAS components that are being sampled, which if released has the potential to release significant contamination into site environmental media, that waste will be sampled. If it is determined that a COC is present at any CAS, that CAS will be further addressed by determining the extent of contamination before evaluating corrective action alternatives.

Because this CAIP only addresses contamination originating from the CAU, it may be necessary to distinguish overlapping contamination originating from other sources. For example, widespread surface radiological contamination originating from atmospheric tests will not be addressed in the CAU 545 investigation. To determine whether contamination is from the CAU or from other sources, soil samples may be collected from outside the influence of releases from the CAS at selected CASs.

Modifications to the investigative strategy may be required should unexpected field conditions be encountered at any CAS. Significant modifications shall be justified and documented before implementation. If an unexpected condition indicates that conditions are significantly different than the corresponding CSM, the activity will be rescoped, and the identified decision makers will be notified.

4.2 Field Activities

Field activities at CAU 545 include site preparation, sample location selection, and sample collection activities.

4.2.1 Site Preparation Activities

Site preparation activities conducted by the NTS Management and Operating Contractor before the investigation may include, but not be limited to: relocating or removing surface debris, equipment, and structures; constructing hazardous waste accumulation areas (HWAAs) and site exclusion zones; providing sanitary facilities; constructing decontamination facilities; and temporarily moving staged equipment.

Before mobilization for collecting investigation samples, the following preparatory activities will also be conducted:

- Perform radiological and/or geophysical surveys.
- Perform visual surveys at all CASs within CAU 545 to identify any staining, discoloration, disturbance of native soils, or any other indication of potential contamination.

4.2.2 Sample Location Selection

At CASs 02-09-01, 03-99-14, 09-23-02, and 20-19-01, biasing factors (including field-screening results) will be used to select the most appropriate samples from a particular location for submittal to the analytical laboratory. Biasing factors to be used for selection of sampling locations are listed in Section A.5.2.1 of Appendix A. As biasing factors are identified and used for selection of sampling locations, they will be documented in the appropriate field documents.

At CAS 03-17-01, a probabilistic sampling approach will be implemented. Sample locations at this CAS are specified in Appendix C. Appendix C lists the sample size and locations as calculated by the VSP software program (PNNL, 2005).

The CAS-specific sampling strategy and the estimated locations of biased samples for each CAS are presented in Appendix A. The number, location, and spacing of step-outs may be modified by the Task Manager or Site Supervisor, as warranted by site conditions to achieve DQO criteria stipulated in Appendix A. Where sampling locations are modified by the Task Manager or Site Supervisor, the justification for these modifications will be documented in the Field Activity Daily Log.

4.2.3 Sample Collection

The CAU 545 sampling program will consist of the following activities:

- Collect and analyze samples from locations as described in this section.
- Collect required QC samples.
- Collect waste management samples.
- Collect soil samples from locations outside the influence of releases from the CAS, if necessary.
- Perform radiological characterization surveys of construction materials and debris as necessary for disposal purposes.
- Record Global Positioning System coordinates for each environmental sample location.

Decision I surface (0 to 0.5 ft bgs) and shallow subsurface soil samples will be collected. If biasing factors are present in soils below locations where original Decision I samples were collected, additional soil samples will also be collected during Decision I sampling, as appropriate. Any additional Decision I subsurface soil samples will collected at depth intervals selected by the Task Manager or Site Supervisor based on biasing factors to a depth where the biasing factors are no longer present. Samples of waste or debris that may contain contaminant(s) will also be sampled to provide sufficient information to determine whether they contain potential source material

Decision II sampling will consist of further defining the extent of contamination where COCs have been confirmed. Step-out (Decision II) sampling locations at each CAS will be selected based on the CSM, biasing factors, field-screening results, existing data, and the outer boundary sample locations where COCs were detected. In general, step-out sample locations will be arranged in a triangular pattern around areas containing a COC at distances based on site conditions, COC concentrations, process knowledge, and biasing factors. If COCs extend beyond step-out locations, additional Decision II samples will be collected from locations further from the source. If a spatial boundary is reached, the CSM is shown to be inadequate, or the Site Supervisor determines that extent sampling needs to be re-evaluated, then work will be temporarily suspended, NDEP will be notified, and the investigation strategy will be re-evaluated. A minimum of one analytical result less than the action level from each lateral and vertical direction will be required to define the extent of COC contamination. The lateral and vertical extent of COCs will only be established based on validated laboratory analytical results (i.e., not field screening).

4.2.4 Sample Management

The laboratory requirements (i.e., detection limits, precision, and accuracy requirements) to be used when analyzing the COPCs are presented in Tables 3-4 and 3-5. The analytical program for each CAS is presented in Table 3-1. All sampling activities and QC requirements for field and laboratory environmental sampling will be conducted in compliance with the Industrial Sites QAPP (NNSA/NV, 2002a) and other applicable, approved procedures.

4.3 Safety

A site-specific health and safety document will be prepared and approved before the field effort. As required by the DOE Integrated Safety Management System (ISMS) (DOE/NV, 1997), this document outlines the requirements for protecting the health and safety of the workers and the public. The

ISMS program requires that site personnel will reduce or eliminate the possibility of injury, illness, or accidents, and will protect the environment during all project activities. The following safety issues will be taken into consideration when evaluating the hazards and associated control procedures in the site-specific health and safety document:

- Potential hazards to site personnel and the public include, but are not limited to: radionuclides, chemicals (e.g., heavy metals, volatile organic compounds [VOCs], semivolatile organic compounds [SVOCs], and petroleum hydrocarbons), adverse and rapidly changing weather, remote location, and motor vehicle and heavy equipment operations.
- Proper training of all site personnel to recognize and mitigate the anticipated hazards.
- Work controls to reduce or eliminate the hazards including engineering controls, substitution of less hazardous materials, and use of appropriate personal protective equipment (PPE).
- Occupational exposure monitoring to prevent overexposures to hazards such as radionuclides, chemicals, and physical agents (e.g., heat, cold, and high wind).
- Radiological surveying for alpha/beta and gamma emitters to minimize and/or control personnel exposures; use of the as-low-as-reasonably-achievable principle when addressing radiological hazards.
- Emergency and contingency planning to include medical care and evacuation, decontamination, spill control measures, and appropriate notification of project management. The same principles apply to emergency communications.
- If presumed asbestos-containing material is identified (CFR, 2006c; NAC, 2006a), it will be inspected and/or samples collected by trained personnel.

4.4 Site Restoration

Following completion of CAI and waste management activities, the following actions will be implemented before closure of the site Real Estate/Operations Permit:

- All equipment, wastes, debris, and materials associated with the CAI will be removed.
- All signage and fencing (unless part of a corrective action) will be removed.
- Site will be graded to pre-investigation condition (unless changed condition is necessary under a corrective action).
- Site will be inspected and certified that restoration activities have been completed.

5.0 Waste Management

Management of investigation-derived waste (IDW) will be based on regulatory requirements, field observations, process knowledge, and laboratory results from CAU 545 investigation samples.

Disposable sampling equipment, PPE, and rinsate are considered potentially contaminated waste only by virtue of contact with potentially contaminated media (e.g., soil) or potentially contaminated debris (e.g., construction materials). Therefore, sampling and analysis of IDW, separate from analyses of site investigation samples, may not be necessary for all IDW. However, if associated investigation samples are found to contain contaminants above regulatory levels, conservative estimates of total waste contaminant concentrations may be made based on the mass of the waste, the amount of contaminated media contained in the waste, and the maximum concentration of contamination found in the media. Direct samples of IDW may also be taken to support waste characterization.

Sanitary, hazardous, radioactive, and/or mixed waste, if generated, will be managed and disposed of in accordance with applicable DOE orders, U.S. Department of Transportation (DOT) regulations, state and federal waste regulations, and agreements and permits between DOE and NDEP.

5.1 Waste Minimization

Investigation activities are planned to minimize IDW generation. This will be accomplished by incorporating the use of process knowledge, visual examination, and/or radiological survey and swipe results. When possible, disturbed media (e.g., soil removed during trenching) or debris will be returned to its original location. Contained media (e.g., soil managed as waste) as well as other IDW will be segregated to the greatest extent possible to minimize generation of hazardous, radioactive, or mixed waste. Hazardous material used at the sites will be controlled in order to limit unnecessary generation of hazardous or mixed waste. Administrative controls, including decontamination procedures and waste characterization strategies, will minimize waste generated during investigations.

5.2 Potential Waste Streams

Waste generated during the investigation activities will include the following potential waste streams:

- Personal protective equipment and disposable sampling equipment (e.g., plastic, paper, sample containers, aluminum foil, spoons, bowls)
- Decontamination rinsate
- Environmental media (e.g., soil)
- Surface debris in investigation area (e.g., metal debris)
- Field-screening waste (e.g., disposable sampling equipment, and/or PPE contaminated by field-screening activities)

5.3 Investigation-Derived Waste Management

The onsite management and ultimate disposition of IDW will be determined based on a determination of the waste type (e.g., sanitary, low-level, hazardous, hydrocarbon, mixed), or the combination of waste types. A determination of the waste type will be guided by several factors, including, but not limited to: the analytical results of samples either directly or indirectly associated with the waste, historical site knowledge, knowledge of the waste generation process, field observations, field-monitoring/screening results, and/or radiological survey/swipe results.

Table 4-2 of the NV/YMP RadCon Manual (NNSA/NSO, 2004b) shall be used to determine whether such materials may be declared nonradioactive. Onsite IDW management requirements by waste type are detailed in the following sections. Applicable waste management regulations and requirements are listed in Table 5-1.

Table 5-1
Waste Management Regulations and Requirements

Waste Type	Federal Regulation	Additional Requirements
Solid (nonhazardous)	N/A	NRS[a] 444.440 - 444.620 NAC[b] 444.570 - 444.7499 NTS Landfill Permit SW 13 097 04[c] rev 5 NTS Landfill Permit SW 13 097 03[d] rev 7
Liquid/Rinsate (nonhazardous)	N/A	Water Pollution Control General Permit GNEV93001, Rev. 3iv[e]
Hazardous	RCRA[f], 40 CFR 260-282	NRS[a] 459.400 - 459.600 NAC[b] 444.850 - 444.8746 POC[g]
Low-Level Radioactive	N/A	DOE Orders and NTSWAC[h]
Mixed	RCRA[f], 40 CFR 260-282	POC[g] NTSWAC[h]
Hydrocarbons	N/A	NTS Landfill Permit SW 13 097 02[i] rev 7 NAC[b] 445A.2272
Polychlorinated Biphenyls	TSCA[j], 40 CFR 761	NRS[a] 459.400 - 459.600 NAC[b] 444.940 - 444.9555
Asbestos	TSCA[j], 40 CFR 763	NRS[a] 618.750 - 618.840 NAC[b] 444.965 - 444.976

[a]*Nevada Revised Statutes* (NRS, 2005a, b, c)
[b]*Nevada Administrative Code* (NAC, 2006a and e)
[c]Area 23 Class II Solid Waste Disposal Site (NDEP 2006a)
[d]Area 9 Class III Solid Waste Disposal Site (NDEP, 2006c)
[e]Nevada Test Site Sewage Lagoons (NDEP 2005)
[f]*Resource Conservation and Recovery Act* (CFR, 2006a)
[g]*Nevada Test Site Performance Objective for the Certification of Nonradioactive Hazardous Waste* (BN, 1995)
[h]*Nevada Test Site Waste Acceptance Criteria,* Rev. 6-02 (NNSA/NSO, 2006b)
[i]Area 6 Class III Solid Waste Disposal Site for hydrocarbon waste (NDEP, 2006b)
[j]*Toxic Substances Control Act* (CFR, 2006b and c)

CFR = *Code of Federal Regulations*
DOE = U.S. Department of Energy
N/A = Not applicable
NAC = *Nevada Administrative Code*
NRS = *Nevada Revised Statutes*
NTS = Nevada Test Site
NTSWAC = *Nevada Test Site Waste Acceptance Criteria*
POC = Performance Objective for the Certification of Nonradioactive Hazardous Waste
RCRA = *Resource Conservation and Recovery Act*
TSCA = *Toxic Substances Control Act*

5.3.1 Sanitary Waste

Sanitary IDW generated at each CAS will be collected, managed, and disposed of in accordance with the sanitary waste management regulations and the permits for operation of the NTS 10c Industrial Waste Landfill (NDEP, 2006b).

Office trash and lunch waste will be placed in the dumpster to be transported to the sanitary landfill for disposal. Sanitary IDW generated at each CAS will only be collected in plastic bags, sealed, labeled with the CAS number from each site in which it was generated, and dated. The waste will then be placed in a roll-off box located in Mercury, or other approved roll-off box location. The number of bags of sanitary IDW placed in the roll-off box will be counted as they are placed in the roll-off box, noted in a log, and documented in the Field Activity Daily Log. These logs will provide necessary tracking information for ultimate disposal in the 10c Industrial Waste Landfill.

5.3.2 Low-Level Radioactive Waste

Radiological swipe surveys and/or direct-scan surveys may be conducted on reusable sampling equipment and the PPE and disposable sampling equipment waste streams exiting a radiologically controlled area (RCA). This allows for the immediate segregation of radioactive waste from waste that may be unrestricted regarding radiological release. Removable contamination limits, as defined in Table 4-2 of the current version of the NV/YMP RadCon Manual (NNSA/NSO, 2004b), will be used to determine whether such waste may be declared unrestricted regarding radiological release versus being declared radioactive waste. Direct sampling of the waste may be conducted to aid in determining whether a particular waste unit (e.g., drum of soil) contains low-level radioactive waste, as necessary. Waste that is determined to be below the values of Table 4-2, by either direct radiological survey/swipe results or through process knowledge, will not be managed as potential radioactive waste but will be managed in accordance with the appropriate section of this document. Wastes in excess of Table 4-2 values will be managed as potential radioactive waste and be managed in accordance with this section and any other applicable sections of this document.

Low-level radioactive waste, if generated, will be managed in accordance with the contractor-specific waste certification program plan, DOE orders, and the requirements of the current version of the *Nevada Test Site Waste Acceptance Criteria* (NTSWAC) (NNSA/NSO, 2006b). Potential radioactive waste drums containing soil, PPE, disposable sampling equipment, and/or rinsate may be staged at a designated radioactive material area (RMA) or RCA when full or at the end of an investigation phase. The waste drums will remain at the RMA pending certification and disposal under NTSWAC requirements (NNSA/NSO, 2006b).

5.3.3 Hazardous Waste

The CAU will have waste accumulation areas established according to the needs of the project. Satellite accumulation areas and HWAAs will be managed consistent with the requirements of federal and state regulations (CFR, 2006a; NAC, 2006b). The HWAAs will be properly controlled for access, and will be equipped with spill kits and appropriate spill containment. Suspected hazardous wastes will be placed in DOT-compliant containers. All containerized hazardous waste will be handled, inspected, and managed in accordance with Title 40 *Code of Federal Regulations* (CFR) 265 Subpart I (CFR, 2006a). These provisions include managing the waste in containers compatible with the waste type, and segregating incompatible waste types so that in the event of a spill, leak, or release, incompatible wastes shall not contact one another. The HWAAs will be covered under a site-specific emergency response and contingency action plan until such time that the waste is determined to be nonhazardous or all containers of hazardous waste have been removed from the storage area. Hazardous waste will be characterized in accordance with the requirement of Title 40 CFR 261 (CFR, 2006a). *Resource Conservation and Recovery Act* (RCRA)-“listed” waste has not been identified at CAU 545. Any waste determined to be hazardous will be managed and transported in accordance with RCRA and DOT requirements to a permitted treatment, storage, and disposal facility (CFR, 2006a).

5.3.4 Hydrocarbon Waste

Hydrocarbon soil waste containing more than 100 milligrams per kilogram of TPH will be managed on site in a drum or other appropriate container until fully characterized. Hydrocarbon waste may be disposed of at a designated hydrocarbon landfill (NDEP, 2006b), an appropriate hydrocarbon waste management facility (e.g., recycling facility), or other method in accordance with Nevada regulations.

5.3.5 Mixed Low-Level Waste

Mixed waste, if generated, shall be managed and dispositioned according to the requirements of RCRA (CFR, 2006a) or subject to agreements between NNSA/NSO and the State of Nevada, as well as DOE requirements for radioactive waste. The waste will be marked with the words "Hazardous Waste Pending Analysis and Radioactive Waste Pending Analysis." Waste characterized as mixed will not be stored for a period of time that exceeds the requirements of RCRA unless subject to agreements between NNSA/NSO and the State of Nevada. The mixed waste shall be transported via an approved hazardous waste/radioactive waste transporter to the NTS transuranic waste storage pad for storage pending treatment or disposal. Mixed waste with hazardous waste constituent concentrations below Land Disposal Restrictions may be disposed of at the NTS Area 5 RWMS if the waste meets the requirements of the NTSWAC (NNSA/NSO, 2006b), the NTS NDEP permit for a Hazardous Waste Management Facility (NEV HW0009 [NDEP, 2000]), and the RCRA Part B Permit Application for Waste Management Activities at the Nevada Test Site (DOE/NV, 1999). Mixed waste constituent concentrations exceeding Land Disposal Restrictions will require development of a treatment and disposal plan under the requirements of the Mutual Consent Agreement between DOE and the State of Nevada (NDEP, 1995).

5.3.6 Polychlorinated Biphenyls

The management of polychlorinated biphenyls (PCBs) is governed by the *Toxic Substances Control Act* (TSCA) (USC, 1976) and its implementing regulations at 40 CFR 761 (CFR, 2006b). Polychlorinated biphenyl contamination may be found as a sole contaminant or in combination with any of the types of waste discussed in this document. For example, PCBs may be a co-contaminant in soil that contains a RCRA "characteristic" waste (PCB/hazardous waste), or in soil that contains radioactive wastes (PCB/radioactive waste), or even in mixed waste (PCB/radioactive/hazardous waste). The IDW will initially be evaluated using analytical results for media samples from the investigation. If any type of PCB waste is generated, it will be managed according to 40 CFR 761 (CFR, 2006b) as well as State of Nevada requirements (NAC, 2006a), guidance, and agreements with NNSA/NSO.

5.4 Management of Specific Waste Streams

5.4.1 Personal Protective Equipment

Personal protective equipment and disposable sampling equipment will be visually inspected for stains, discoloration, and gross contamination as the waste is generated, and evaluated for radiological contamination. Staining and/discoloration will be assumed to be the result of contact with potentially contaminated media such as soil, sludge, or liquid. Gross contamination is the visible contamination of an item (e.g., clumps of soil/sludge on a sampling spoon or free liquid smeared on a glove). While gross contamination can often be removed through decontamination methods, removal of gross contamination from small items, such as gloves or booties is not typically conducted. Any IDW that meets this description will be segregated and managed as potentially "characteristic" hazardous waste. This segregated population of waste will either: (1) be assigned the characterization of the soil/sludge that was sampled, (2) be sampled directly, or (3) undergo further evaluation using the soil/sludge sample results to determine how much soil/sludge would need to be present in the waste to exceed regulatory levels. Waste that is determined to be hazardous will be entered into an approved waste management system, where it will be managed and dispositioned according to RCRA requirements or subject to agreements between NNSA/NSO and the State of Nevada. The PPE and equipment that is not visibly stained, discolored, or grossly contaminated and that is within the radiological free-release criteria will be managed as nonhazardous sanitary waste.

5.4.2 Management of Decontamination Rinsate

Rinsate at CAU 545 will not be considered hazardous waste unless there is evidence that the rinsate may display a RCRA characteristic. Evidence may include such things as the presence of a visible sheen, pH, or association with equipment/materials used to respond to a release/spill of a hazardous waste/substance. Decontamination rinsate that is potentially hazardous (using associated sample results and/or process knowledge) will be managed as characteristic hazardous waste (CFR, 2006a). The regulatory status of the potentially hazardous rinsate will be determined through the application of associated sample results or through direct sampling. If the associated samples do not indicate the presence of hazardous constituents, then the rinsate will be considered to be nonhazardous.

The disposal of nonhazardous rinsate will be consistent with guidance established in current NNSA/NSO Fluid Management Plans for the NTS as follows:

- Rinsate that is determined to be nonhazardous and containing constituents whose concentrations are at or below the limits identified in the NTS lagoon permit (NDEP, 2005) is acceptable for disposal.
- Nonhazardous rinsate containing constituents whose concentrations exceed the limits identified in the NTS lagoon permit (NDEP, 2005) will be disposed of in an evaporation basin with written approval from NDEP or solidified and disposed of as sanitary waste or low-level waste in accordance with the respective sections of this document.

5.4.3 Management of Soil

This waste stream consists of soil removed for disposal during soil sampling, excavation, and/or drilling. This waste stream will be characterized based on laboratory analytical results from representative locations. If the soil is determined to potentially contain COCs, the material will either be managed on site or containerized for transportation to an appropriate disposal site.

Onsite management of the waste soil will be allowed only if it is managed within an area of concern and it is appropriate to defer the management of the waste until the final remediation of the site. If this option is chosen, the waste soil shall be protected from run-on and runoff using appropriate protective measures based on the type of contaminant(s) (e.g., covered with plastic and bermed).

Management of soil waste for disposal consists of placing the waste in containers, labeling the containers, temporarily storing the containers until shipped, and shipping the waste to a disposal site. The containers, labels, management of stored waste, transport to the disposal site, and disposal shall be appropriate for the type of waste (e.g., hazardous, hydrocarbon, mixed).

Note that soils placed back into a borehole or excavation in the same approximate location from which it originated is not considered to be a waste.

5.4.4 Management of Debris

This waste stream can vary depending on site conditions. Debris that requires removal for the investigation activities (soil sampling, excavation, and/or drilling) must be characterized for proper management and disposition. Historical site knowledge, knowledge of the waste generation process, field observations, field-monitoring/screening results, radiological survey/swipe results and/or the analytical results of samples either directly or indirectly associated with the waste may be used to characterized the debris. Debris will be visually inspected for stains, discoloration, and gross contamination. Debris may be deemed reusable, recyclable, sanitary waste, hazardous waste, PCB waste, or low-level waste. Waste that is not sanitary will be entered into an approved waste management system, where it will be managed and dispositioned according to federal, state requirements, and agreements between NNSA/NSO and the State of Nevada. The debris will either be managed on site by berming and covering next to the excavation, by placement in a container(s), or left on the footprint of the CAS and its disposition deferred until implementation of corrective action at the site.

5.4.5 Field-Screening Waste

The use of field test kits and/or instruments may result in the generation of small quantities of hazardous wastes. If hazardous waste is produced by field screening, it will be segregated from other IDW and managed in accordance with the hazardous waste regulations (CFR, 2006a). For sites where field-screening samples contain radioactivity above background levels, field-screening methods that have the potential to generate hazardous waste will not be used, thus avoiding the potential to generate mixed waste. In the event a mixed waste is generated, the waste will be managed in accordance with Section 5.3.5 of this document.

6.0 Quality Assurance/Quality Control

The overall objective of the characterization activities described in this CAIP is to collect accurate and defensible data to support the selection and implementation of a closure alternative for each CAS in CAU 545. Sections 6.1 and 6.2 discuss the collection of required QC samples in the field and QA requirements for laboratory/analytical data to achieve closure. Unless otherwise stated in this CAIP or required by the results of the DQO process (see Appendix A), this investigation will adhere to the Industrial Sites QAPP (NNSA/NV, 2002a).

6.1 Quality Control Sampling Activities

Field QC samples will be collected in accordance with established procedures. Field QC samples are collected and analyzed to aid in determining the validity of environmental sample results. The number of required QC samples depends on the types and number of environmental samples collected. The minimum frequency of collecting and analyzing QC samples for this investigation, as determined in the DQO process, include:

- Trip blanks (1 per sample cooler containing VOC environmental samples)
- Equipment rinsate blanks (1 per sampling event for each type of decontamination procedure)
- Source blanks (1 per lot of uncharacterized source material that contacts sampled media)
- Field duplicates (1 per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected)
- Field blanks (may be 1 per 20 environmental samples, 1 per day, or 1 per CAS depending on site conditions and agreement of DQO participants)
- Laboratory QC samples (1 per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected)

Additional QC samples may be submitted based on site conditions at the discretion of the Task Manager or Site Supervisor. Field QC samples shall be analyzed using the same analytical procedures implemented for associated environmental samples. Additional details regarding field QC samples are available in the Industrial Sites QAPP (NNSA/NV, 2002a).

6.2 Laboratory/Analytical Quality Assurance

Criteria for the investigation, as stated in the DQOs (Appendix A) and except where noted, require laboratory analytical quality data be used for making critical decisions. Rigorous QA/QC will be implemented for all laboratory samples including documentation, data verification and validation of analytical results, and an assessment of DQIs as they relate to laboratory analysis.

6.2.1 Data Validation

Data verification and validation will be performed in accordance with the Industrial Sites QAPP (NNSA/NV, 2002a), except where otherwise stipulated in this CAIP. All chemical and radiological laboratory data from samples that are collected and analyzed will be evaluated for data quality according to company-specific procedures. The data will be reviewed to ensure that all suspected samples were appropriately collected, analyzed, and the results passed data validation criteria. Validated data, including estimated data (i.e., J-qualified), will be assessed to determine whether they meet the DQO requirements of the investigation and the performance criteria for the DQIs. The results of this assessment will be documented in the Corrective Action Decision Document. If the DQOs were not met, corrective actions will be evaluated, selected, and implemented (e.g., refine CSM or resample to fill data gaps).

6.2.2 Data Quality Indicators

The DQIs are qualitative and quantitative descriptors used in interpreting the degree of acceptability or utility of data. Data quality indicators are used to evaluate the entire measurement system and laboratory measurement processes (i.e., analytical method performance) as well as to evaluate individual analytical results (i.e., parameter performance). The quality and usability of data used to make DQO decisions will be assessed based on the following DQIs:

- Precision
- Accuracy
- Representativeness
- Completeness
- Comparability
- Sensitivity

Table 6-1 provides the established analytical method/measurement system performance criteria for each of the DQIs and the potential impacts to the decision if the criteria are not met. The following subsections discuss each of the DQIs that will be used to assess the quality of laboratory data. Due to changes in analytical methodology and changes in analytical laboratory contracts, criteria for precision and accuracy in Tables 3-4 and 3-5 that vary from corresponding information in the QAPP will supersede that information in the QAPP (NNSA/NV, 2002a).

Table 6-1
Laboratory and Analytical Performance Criteria for CAU 545 Data Quality Indicators
(Page 1 of 2)

Data Quality Indicator	Performance Metric	Potential Impact on Decision If Performance Metric Not Met
Precision	At least 80% of the sample results for each measured contaminant are not qualified for precision based on the criteria for each analytical method-specific and laboratory-specific criteria presented in Section 6.2.3.	If the performance metric is not met, the affected analytical results from each affected CAS will be assessed to determine whether there is sufficient confidence in analytical results to use the data in making DQO decisions.
Accuracy	At least 80% of the sample results for each measured contaminant are not qualified for accuracy based on the method-specific and laboratory-specific criteria presented in Section 6.2.4.	If the performance metric is not met, the affected analytical results from each affected CAS will be assessed to determine whether there is sufficient confidence in analytical results to use the data in making DQO decisions.
Sensitivity	Minimum detectable concentrations are less than or equal to respective FALs.	Cannot determine whether COCs are present or migrating at levels of concern.
Comparability	Sampling, handling, preparation, analysis, reporting, and data validation are performed using standard methods and procedures.	Inability to combine data with data obtained from other sources and/or inability to compare data to regulatory action levels.
Representativeness	Samples contain contaminants at concentrations present in the environmental media from which they were collected.	Analytical results will not represent true site conditions. Inability to make appropriate DQO decisions.
Completeness	80% of the CAS-specific COPCs have valid results. 100% of CAS-specific targeted contaminants have valid results.	Cannot support/defend DQO decision on whether COCs are present.
Extent Completeness	100% of COCs used to define extent have valid results.	Extent of contamination cannot be accurately determined.

Table 6-1
Laboratory and Analytical Performance Criteria for CAU 545 Data Quality Indicators
(Page 2 of 2)

Data Quality Indicator	Performance Metric	Potential Impact on Decision If Performance Metric Not Met
Clean Closure Completeness	100% of targeted contaminants have valid results.	Cannot determine whether COCs remain in soil.

CAS = Corrective action site
COC = Contaminant of concern
COPC = Contaminant of potential concern
DQO = Data quality objective
FAL = Final action level

6.2.3 Precision

Precision is a measure of the repeatability of the analysis process from sample collection through analysis results. It is used to assess the variability between two equal samples.

Determinations of precision will be made for field duplicate samples and laboratory duplicate samples. Field duplicate samples will be collected simultaneously with samples from the same source under similar conditions in separate containers. The duplicate sample will be treated independently of the original sample in order to assess field impacts and laboratory performance on precision through a comparison of results. Laboratory precision is evaluated as part of the required laboratory internal QC program to assess performance of analytical procedures. The laboratory sample duplicates are an aliquot, or subset, of a field sample generated in the laboratory. They are not a separate sample but a split, or portion, of an existing sample. Typically, laboratory duplicate QC samples may include matrix spike duplicate (MSD) and laboratory control sample (LCS) duplicate samples for organic, inorganic, and radiological analyses.

Precision is a quantitative measure used to assess overall analytical method and field-sampling performance as well as to assess the need to “flag” (qualify) individual parameter results when corresponding QC sample results are not within established control limits.

The criteria used for the assessment of inorganic chemical precision when both results are greater than or equal to 5x reporting limit (RL) is 20 percent and 35 percent for aqueous and soil samples, respectively. When either result is less than 5x RL, a control limit of ±1x RL and ±2x RL for aqueous and soil samples, respectively, is applied to the absolute difference.

The criteria used for the assessment of organic chemical precision is based on professional judgment using laboratory derived control limits and gas chromatography column comparison.

The criteria used for the assessment of radiological precision when both results are greater than or equal to 5x MDC is 20 percent and 35 percent for aqueous and soil samples, respectively. When either result is less than 5x MDC, the normalized difference (ND) should be between -2 and +2 for aqueous and soil samples. The parameters to be used for assessment of precision for duplicates are listed in Table 3-5.

Any values outside the specified criteria do not necessarily result in the qualification of analytical data. It is only one factor in making an overall judgment about the quality of the reported analytical results. The performance metric for assessing the DQI of precision on DQO decisions (Table 6-1) is that at least 80 percent of sample results for each measured contaminant are not qualified due to duplicates exceeding the criteria. If this performance is not met, an assessment will be conducted in the investigation report on the impacts to DQO decisions specific to affected contaminants and CASs.

6.2.4 Accuracy

Accuracy is a measure of the closeness of an individual measurement to the true value. It is used to assess the performance of laboratory measurement processes.

Accuracy is determined by analyzing a reference material of known parameter concentration or by reanalyzing a sample to which a material of known concentration or amount of parameter has been added (spiked). Accuracy will be evaluated based on results from three types of spiked samples: matrix spike (MS), LCS, and surrogates (organics). The LCS sample is analyzed with the field samples using the same sample preparation, reagents, and analytical methods employed for the samples. One LCS will be prepared with each batch of samples for analysis by a specific measurement.

The criteria used for the assessment of inorganic chemical accuracy are 75 to 125 percent for MS recoveries and 80 to 120 percent for LCS recoveries. For organic chemical accuracy, MS and LCS laboratory-specific percent recovery criteria developed and generated in-house by the laboratory according to approved laboratory procedures are applied. The criteria used for the assessment of radiochemical accuracy are 80 to 120 percent for LCS and MS recoveries.

Any values outside the specified criteria do not necessarily result in the qualification of analytical data. It is only one factor in making an overall judgment about the quality of the reported analytical results. Factors beyond laboratory control, such as sample matrix effects, can cause the measured values to be outside of the established criteria. Therefore, the entire sampling and analytical process may be evaluated when determining the usability of the affected data.

The performance metric for assessing the DQI of accuracy on DQO decisions (Table 6-1) is that at least 80 percent of the sample results for each measured contaminant are not qualified for accuracy. If this performance is not met, an assessment will be conducted in the investigation report on the impacts to DQO decisions specific to affected contaminants and CASs.

6.2.5 Representativeness

Representativeness is the degree to which sample characteristics accurately and precisely represent a characteristics of a population or an environmental condition (EPA, 2002). Representativeness is assured by a carefully developing the sampling strategy during the DQO process such that false negative and false positive decision errors are minimized. The criteria listed in DQO Step 6 – Specify the Tolerable Limits on Decision Errors are:

- For Decision I judgmental sampling, having a high degree of confidence that the sample locations selected will identify COCs if present anywhere within the CAS.
- For Decision I probabilistic sampling, having a high degree of confidence that the sample locations selected will represent contamination of the CAS.
- Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples.
- For Decision II, having a high degree of confidence that the sample locations selected will identify the extent of COCs.

These are qualitative measures that will be used to assess measurement system performance for representativeness. The assessment of this qualitative criterion will be presented in the investigation report.

6.2.6 Completeness

Completeness is defined as generating sufficient data of the appropriate quality to satisfy the data needs identified in the DQOs. For judgmental sampling, completeness will be evaluated using both a quantitative measure and a qualitative assessment. The quantitative measurement to be used to evaluate completeness is presented in Table 6-1 and is based on the percentage of measurements made that are judged to be valid.

For the judgmental sampling approach, the completeness goal for targeted contaminants and the remaining COPCs is 100 and 80 percent, respectively. If this goal is not achieved, the dataset will be assessed for potential impacts on making DQO decisions. For the probabilistic sampling approach, the completeness goal is a calculated minimum sample size required to produce a valid statistical comparison of the sample mean to the FAL. The methodology for determining minimum required sample size is described in Appendix C.

The qualitative assessment of completeness is an evaluation of the sufficiency of information available to make DQO decisions. This assessment will be based on meeting the data needs identified in the DQOs and will be presented in the investigation report. Additional samples will be collected if it is determined that the number of samples do not meet completeness criteria.

6.2.7 Comparability

Comparability is a qualitative parameter expressing the confidence with which one dataset can be compared to another (EPA, 2002). The criteria for the evaluation of comparability will be that all sampling, handling, preparation, analysis, reporting, and data validation were performed and documented in accordance with approved procedures that are in conformance with standard industry practices. Analytical methods and procedures approved by DOE will be used to analyze, report, and validate the data. These methods and procedures are in conformance with applicable methods used in industry and government practices. An evaluation of comparability will be presented in the investigation report.

6.2.8 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest (EPA, 2002). The evaluation criteria for this parameter will be that measurement sensitivity (detection limits) will be less than or equal to the corresponding FALs. If this criterion is not achieved, the affected data will be assessed for usability and potential impacts on meeting site characterization objectives. This assessment will be presented in the investigation report.

7.0 Duration and Records Availability

7.1 Duration

Table 7-1 is a tentative duration of activities (in calendar days) for CAI activities.

Table 7-1
Corrective Action Investigation Activity Durations

Duration (days)	Activity
10	Site Preparation
76	Fieldwork Preparation and Mobilization
55	Sampling
160	Data Assessment
180	Waste Management

7.2 Records Availability

Historic information and documents referenced in this plan are retained in the NNSA/NSO project files in Las Vegas, Nevada, and can be obtained through written request to the NNSA/NSO Federal Project Director. This document is available in the DOE public reading rooms located in Las Vegas and Carson City, Nevada, or by contacting the appropriate DOE Federal Sub-Project Director. The NDEP maintains the official Administrative Record for all activities conducted under the auspices of the FFACO.

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Appendix A

Data Quality Objectives

A.1.0 Introduction

The DQO process described in this appendix is a seven-step strategic systematic planning method used to plan data collection activities and define performance criteria for the CAU 545, Dumps, Waste Disposal Sites, and Buried Radioactive Material, field investigation. The DQOs are designed to ensure that the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend recommended corrective actions (i.e., no further action, closure in place, or clean closure). Existing information about the nature and extent of contamination at the CASs in CAU 545 is insufficient to evaluate and select preferred corrective actions; therefore, a CAI will be conducted.

The CAU 545 investigation will be based on the DQOs presented in this appendix as developed by representatives of the NDEP and the NNSA/NSO. The seven steps of the DQO process presented in Sections A.3.0 through A.9.0 were developed in accordance with *EPA Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006).

The DQO process presents a combination of probabilistic and judgmental sampling approaches. In general, the procedures used in the DQO process provide:

- A method to establish performance or acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of a study.
- Criteria that will be used to establish the final data collection design such as:
    - The nature of the problem that has initiated the study and a conceptual model of the environmental hazard to be investigated.
    - The decisions or estimates that need to be made and the order of priority for resolving them.
    - The type of data needed.
    - An analytic approach or decision rule that defines the logic for how the data will be used to draw conclusions from the study findings.

- Acceptable quantitative criteria on the quality and quantity of the data to be collected, relative to the ultimate use of the data.

- A data collection design that will generate data meeting the quantitative and qualitative criteria specified. A data collection design specifies the type, number, location, and physical quantity of samples and data, as well as the QA and QC activities that will ensure that sampling design and measurement errors are managed sufficiently to meet the performance or acceptance criteria specified in the DQOs.

A.2.0 Background Information

The following eight CASs that comprise CAU 545 are located in Areas 2, 3, 9, and 20 of the NTS, as shown in Figure A.2-1:

- CAS 02-09-01, Mud Disposal Area
- CAS 03-08-03, Mud Disposal Site
- CAS 03-17-01, Waste Consolidation Site 3B
- CAS 03-23-02, Waste Disposal Site
- CAS 03-23-05, Europium Disposal Site
- CAS 03-99-14, Radioactive Material Disposal Area
- CAS 09-23-02, U-9y Drilling Mud Disposal Crater

The following sections (Sections A.2.1 through A.2.3) provide a CAS description, physical setting and operational history, release information, and previous investigation results for each CAS in CAU 545. The CASs are divided into three groupings of similar sites based on process knowledge, operational history, and/or the physical setting:

- Corrective Action Sites 02-09-01, 03-08-03, and 09-23-02, which are primarily craters used for mud disposal

- Corrective Action Sites 03-23-02, 03-23-05, and 20-19-01, which are sites where surface or buried waste was disposed within craters or potential crater areas

- Corrective Action Sites 03-17-01 and 03-99-14, which are sites where surface or buried waste was disposed, but where the physical setting is not within craters or potential crater areas (i.e., crater areas that have not subsided)

The CAS-specific COPCs are provided in the following sections. Many of the COPCs are based on a conservative evaluation of possible site activities considering the incomplete site histories of the CASs and considering contaminants found at similar NTS sites. Targeted contaminants are defined as those contaminants that are known or that could be reasonably suspected to be present within the CAS based on previous sampling or process knowledge.

A.2.1 Group 1: CASs Associated with Mud Disposal and Craters

This grouping of sites comprises CASs 02-09-01, 03-08-03, and 09-23-02, which are primarily craters used for mud disposal purposes.

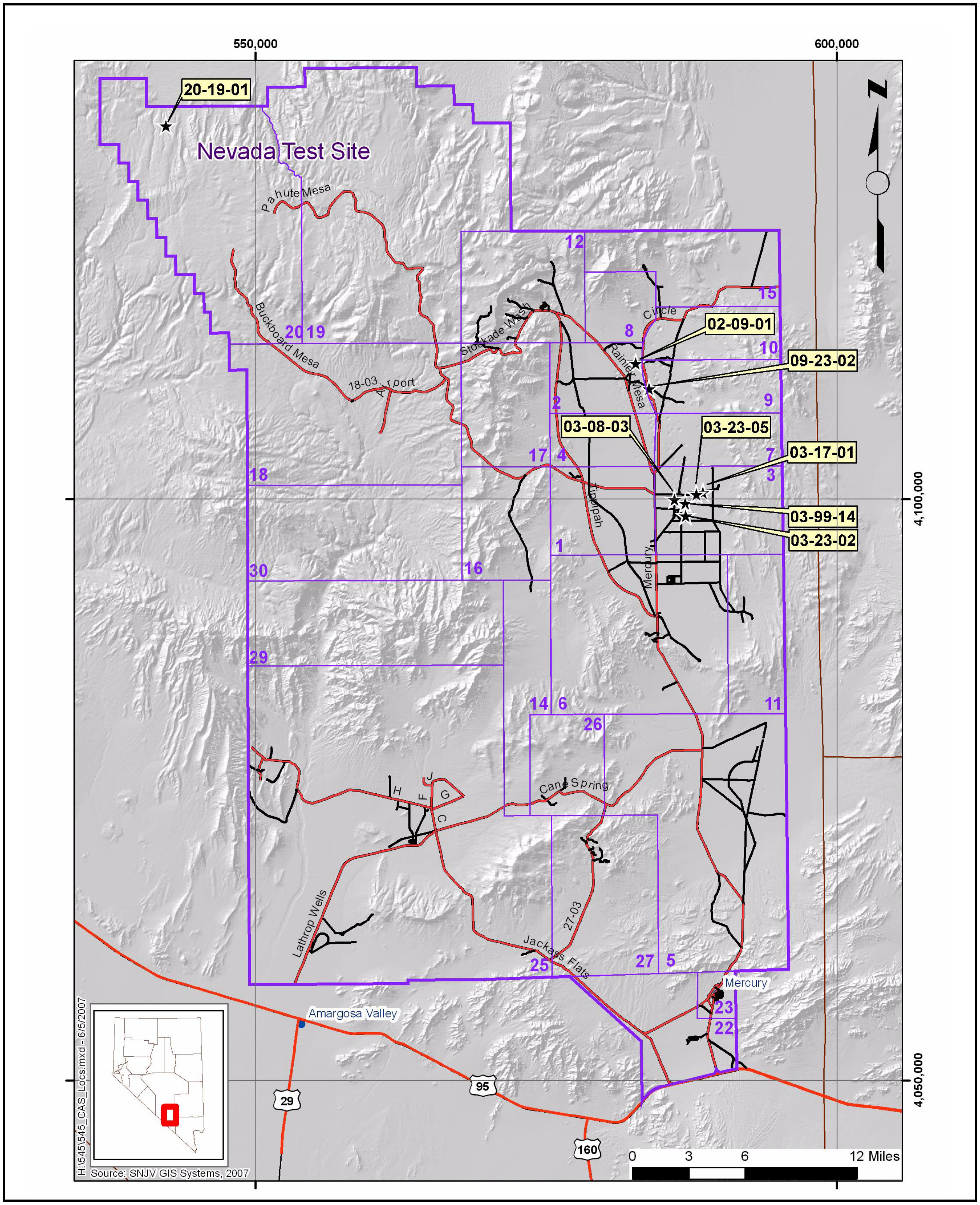

Figure A.2-1
Corrective Action Unit 545, CAS Location Map

A.2.1.1 Corrective Action Site 02-09-01, Mud Disposal Area

Corrective Action Site 02-09-01 consists of mud released within and outside of the U-2ei crater, located in Area 2. Figure A.2-2 shows a aerial view of the CAS and surrounding area. The west mud disposal area and the flow into the crater are shown in Figure A.2-3.

Physical Setting – Three geographically distinct mud disposal areas have been identified. Large volumes of mud were disposed within and outside of the west and south sides of the crater, and smaller volumes of mud were released outside of the southeast crater edge, adjacent to the 2-05 Road. The three mud disposal areas are also distinct in composition. The west mud disposal area consists of a light brown mud with abundant cobble-sized rocks; the south mud disposal area consists of a white-gray bentonite, and the southeast mud disposal area consists of a uniform brown mud. The fencing extends beyond the edge of the crater and encloses most of the mud released outside of the crater. The crater area is not posted and a stability study has not been conducted; thus, this crater is not considered to be safe for entry.

Operational History – Corrective Action Site 02-09-01 consists of mud released within and outside of the U-2ei crater, which formed as a result of the Coulommiers underground nuclear test, conducted on September 27, 1977. During underground testing activities, earthen mud pits and craters were used for the disposal of drilling mud (NNSA/NSO, 2004a). Radiologically contaminated drilling muds and decontamination waste waters were frequently taken to designated craters and disposed, instead of being released to a mud pit (DOE, 1988). The specific history of mud disposal activities at the U-2ei crater is unknown; however, aerial photography indicates mud was disposed at the site between 1977 and 1984. The mud released at CAS 02-09-01 is assumed to be associated with NTS drilling operations, and therefore may either be preuse material or else used pre-test and/or post-test drilling mud. The crater area is fenced but not posted, and no stability study has been conducted at this site; thus, this crater is not considered to be safe for entry. Figure A.2-2 shows the features of CAS 02-09-01 and surrounding vicinity.

Release Information – There is the potential for an environmental release associated with the disposal of mud within and outside of the U-2ei crater to have occurred. The mud released at CAS 02-09-01 is considered to be potentially impacted by radiological contamination based on limited process knowledge and operational history.

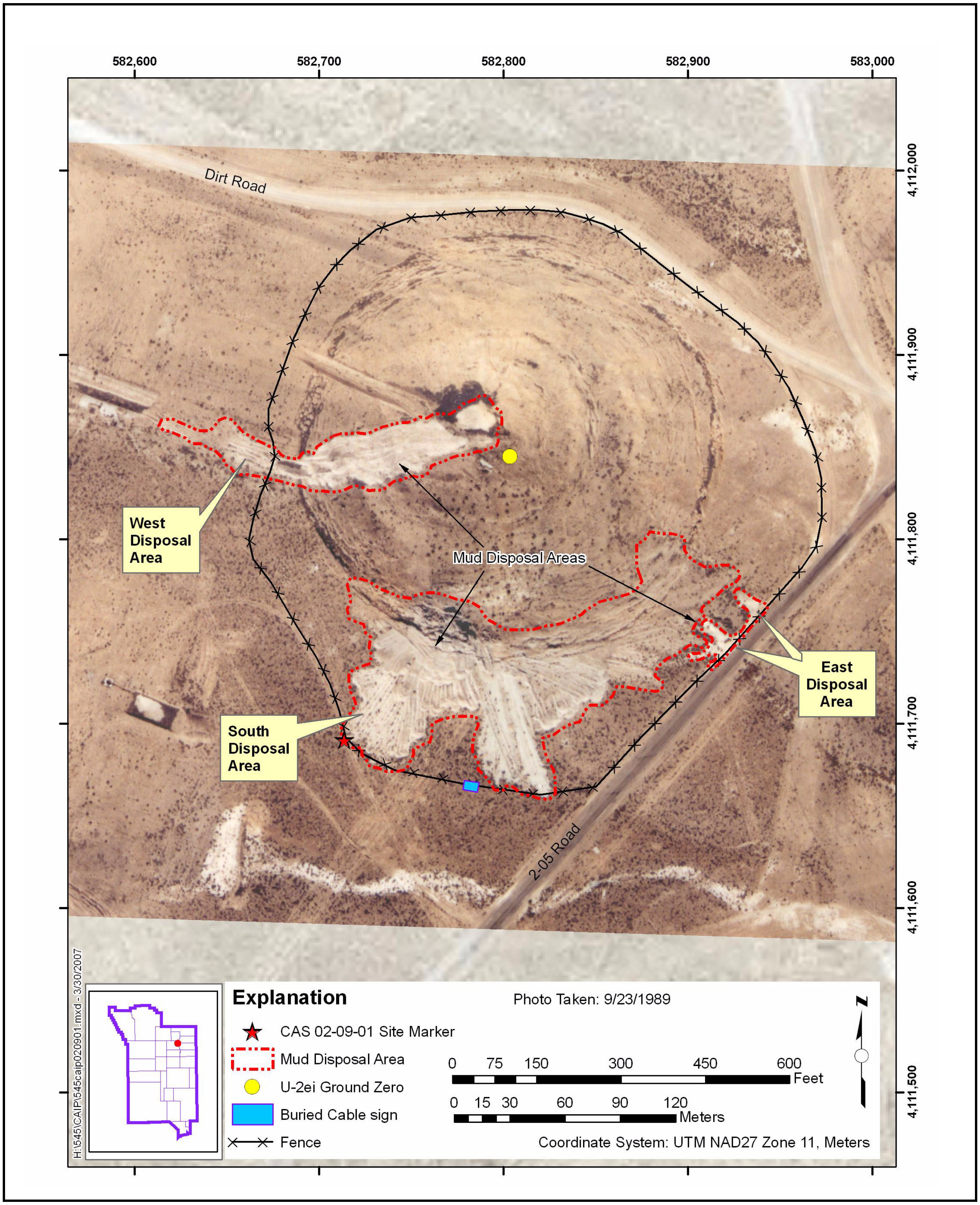

Figure A.2-2
Aerial View of CAS 02-09-01, Mud Disposal Area, and Vicinity

Figure A.2-3
CAS 02-09-01, West Mud Disposal Area and U-2ei Crater

Previous Investigation Results – No previous investigations have been identified for this CAS.

A.2.1.2 Corrective Action Site 03-08-03, Mud Disposal Site

Corrective Action Site 03-08-03 consists of the release of post-test drilling mud within the U-3ai/U-3be joined craters, located in Area 3. Four post-shot boreholes that have been drilled at the crater floor of U-3ai are under the control of the Borehole Management Program and are not included in the scope of CAS 03-08-03. Figure A.2-4 shows an aerial view of the CAS and surrounding area. A portion of the U-3ai crater within CAS 03-08-03 is shown in Figure A.2-5.

Physical Setting – A post-test topographic map shows that the U-3ai crater is approximately 45 ft deep and the U-3be crater is approximately 100 ft deep (AAS and H&N, 1962a, b). An accumulation of mud observed across the floor of both craters is suspected to range from at least 10 to 30 ft thick. Excavated or eroded areas at the north side of the U-3ai crater and the east and west sides of the U-3be crater are suspected to be discharge areas for the release of drilling mud. The mud observed within the crater varies in color and is assumed to vary in consistency because this crater received deliveries of drilling mud for more than 25 years. The U-3ai/U-3be crater edge is fenced and posted as an RMA. The northern portion of U-3ai crater fencing is also the southern boundary of a fenced contamination area (CA) (Figure A.2-5) not associated with CAS 03-08-03 (i.e., separately investigated for CAU 104 in the Soils Project). A crater stability study that was conducted at U-3ai/U-3be concluded that the potential for additional subsidence is extremely unlikely (LANL, date unknown).

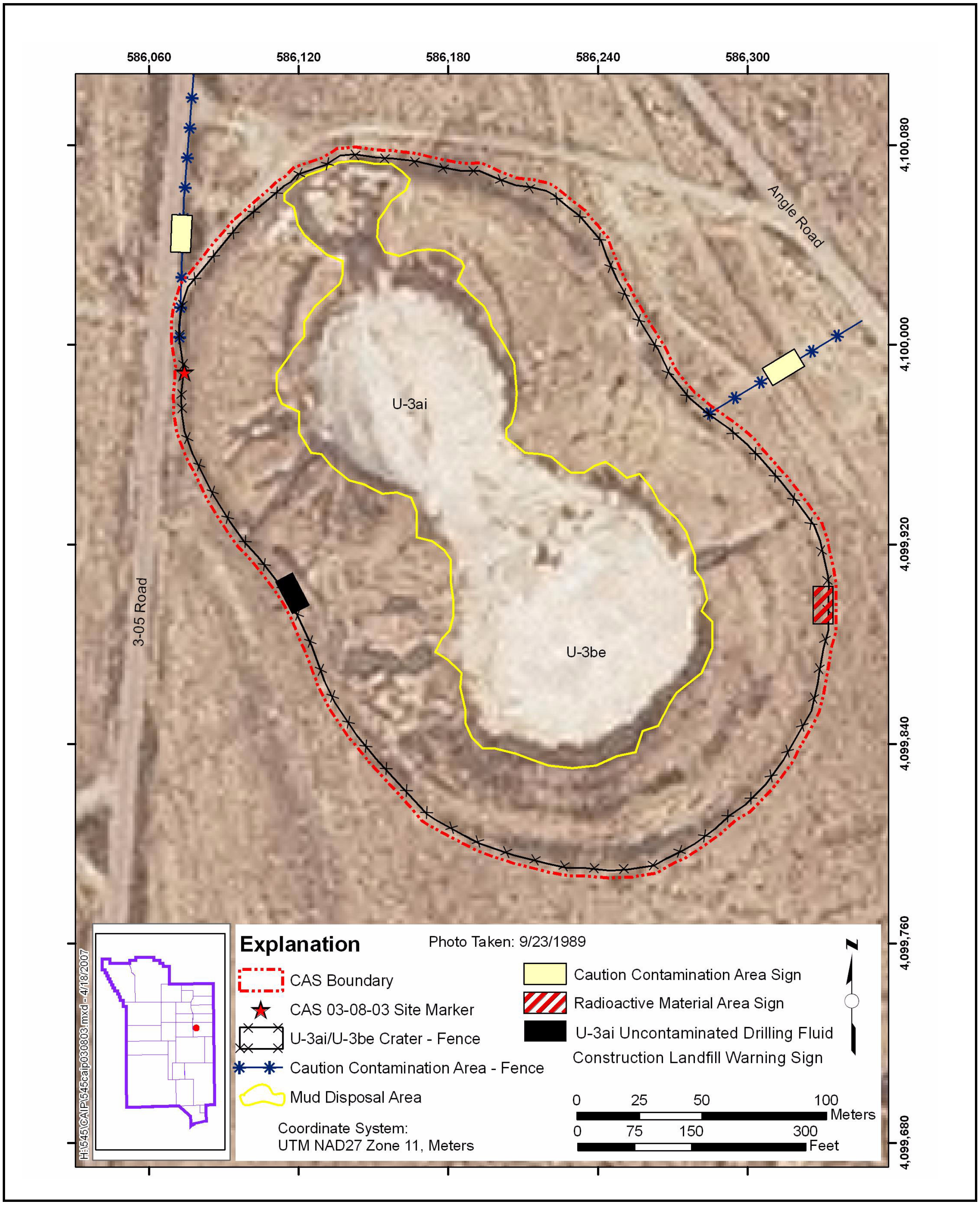

Figure A.2-4
Aerial View of CAS 03-08-03, Mud Disposal Site, and Vicinity

Figure A.2-5
Portion of the U-3ai Crater within CAS 03-08-03

Operational History – U-3ai and U-3be craters were formed as a result of the Hognose (March 15, 1962) and Daman I (June 21, 1962) underground nuclear tests, respectively. In 1965, the U-3ai/U-3be craters were used as a disposal site for post-test drilling mud and decontamination wastewaters, including radiologically contaminated drilling mud and possibly chromium-contaminated mud (DOE, 1988; Frazier, 1987). In 1989, the DOE/NV identified the U-3ai/U-3be landfill as a location that was not in compliance with applicable federal and state laws and requested that REECo immediately close the landfill (Fitzsimmons, 1989). Mud and sediment in the crater were sampled for radioactivity in 1989, and results showed no activity above background levels. In 1990, an Operations and Maintenance Plan reclassified the landfill as a Class III Construction Landfill, which restricts the disposal of materials to nonradioactive and nonhazardous drilling fluids (Elle, 1990). Although the official date of closure for the landfill is unknown, vacuum truck deliveries of waste drilling fluids are documented into 1993.

Release Information – There is the potential for an environmental release associated with the disposal of mud within the U-3ai/U-3be crater. The mud released at CAS 03-08-03 is considered to be potentially impacted by radiological contamination based on limited process knowledge and operational history.

Previous Investigation Results – Mud and sediment in the U-3ai/U-3be crater was sampled in September 1989 as part of an Environmental Survey Action Plan (DOE/NV, 1990). Samples were taken from six locations (three from each semicrater) at depths that did not exceed 4 ft bgs. The investigation appears to have been planned in 1988 for the purpose of addressing concerns that radiologically contaminated and/or chromium-contaminated drilling muds were disposed in the crater. An Environmental Survey Action Plan reports that samples were analyzed for radioactivity, and results showed no activity above background levels; however, actual data for the results were not included in the report (DOE/NV, 1990). The report does not mention any chemical analysis.

A.2.1.3 Corrective Action Site 09-23-02, U-9y Drilling Mud Disposal Crater

Corrective Action Site 09-23-02 consists of two separate components: the release of post-test drilling mud within the U-9y crater (the crater component) and a release(s) associated with potential buried material within a posted URMA (the wash component) adjacent to the U-9y crater. Figure A.2-6 shows an aerial view of the CAS and surrounding area. The wash component of CAS 09-23-02 is shown in Figure A.2-7.

Physical Setting – The U-9y crater, which was used for the disposal of radiologically contaminated drilling fluids and decontamination wastewater, is approximately 500 ft in diameter. A topographic map shows that the crater was approximately 40 ft deep following the underground test (H&N, 1962). Based on visual observations and the known depth of the crater, it is estimated that the thickness of mud ranges from 10 to 20 ft. Historical documentation indicates that the crater was filled to capacity and that mud spilled over into an adjacent wash (Bingham, 1992). A 245-by-115-ft portion of the wash, near the site access road is posted as an URMA. It is unknown whether mud was actually released to this drainage or whether buried waste/debris is present at the URMA. A thin layer of weathered grout is present at the eastern wall of the crater. The crater is fenced and posted as a CA, and a crater stability study has not been conducted; therefore, the crater is not considered to be safe for entry. No significant debris was identified at this site.

Operational History – The U-9y crater associated with CAS 09-23-02 formed as a result of the Wichita underground nuclear test, conducted on July 27, 1962. The U-9y crater was subsequently used for the disposal of post-test drilling mud and decontamination wastewaters, including radiologically contaminated drilling mud and possibly chromium-contaminated mud, until the late 1970s (DOE, 1988; Bingham, 1992). The specific activities and operational history associated with the posted URMA are not known. A map from the NTS Contaminated Land Areas Report, Volume I, shows that the wash adjacent to the U-9y crater was posted as “Buried Radioactive Material” as of the year 2000 (DOE/NV, 2000); it is not known when the posted area became an URMA.

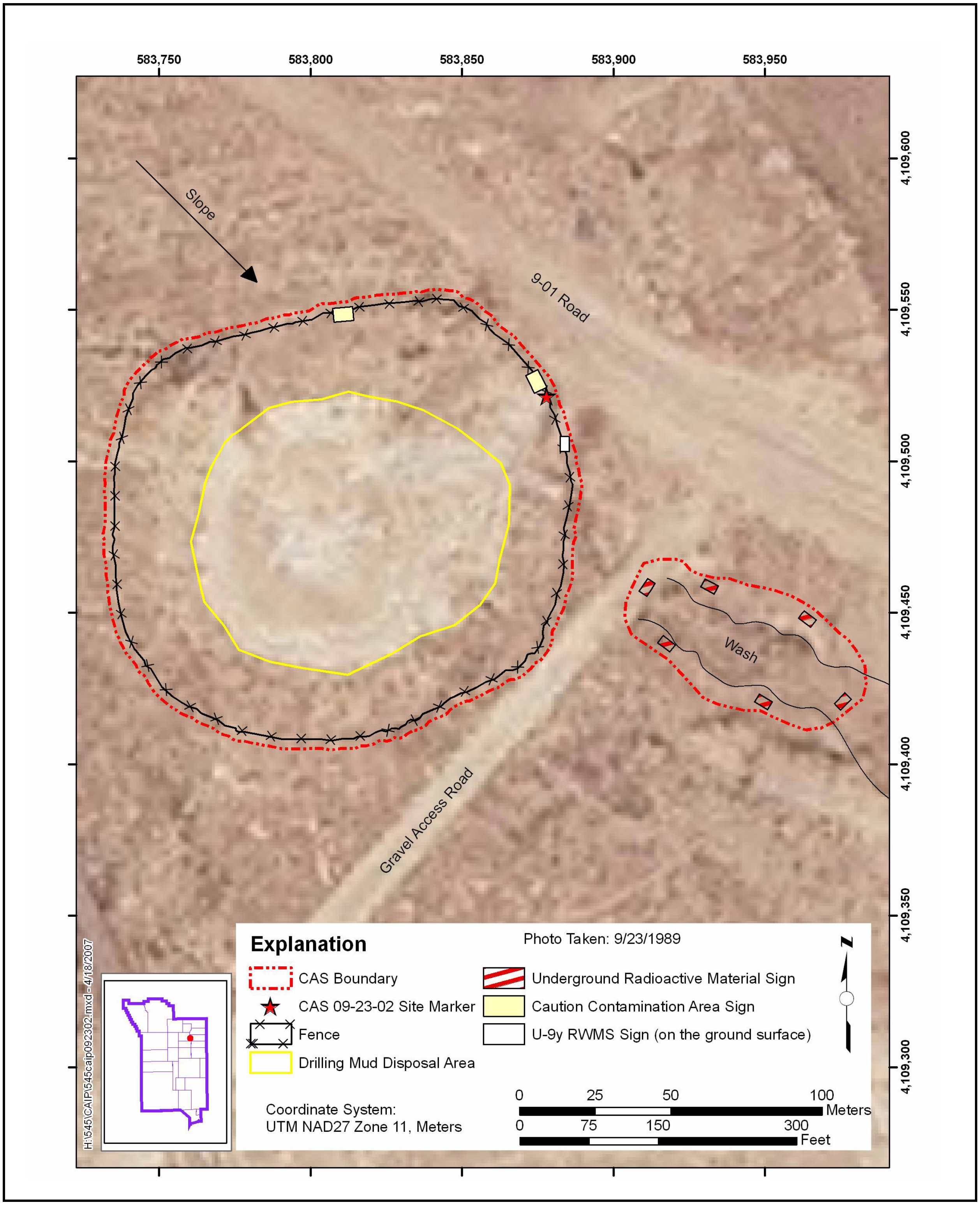

Figure A.2-6
Aerial View of CAS 09-23-02, U-9y Drilling Mud Disposal Crater, and Vicinity

Figure A.2-7
Wash Component of CAS 09-23-02

Release Information – There is the potential for an environmental release associated with the disposal of mud or decontamination waste water within the U-9y crater, and potentially to the adjacent wash, to have occurred. The mud released at CAS 09-23-02 is potentially impacted by radiological contamination based on process knowledge and operational history. There is also the potential for an environmental release associated with potential buried waste/debris at the URMA to have occurred. Based on the URMA postings, a release is expected to include radiological contaminants, but may also include organic and inorganic chemical constituents because the type of buried material is unknown.

Previous Investigation Results – No previous investigations have been identified for this CAS.

A.2.2 Group 2: CASs Associated with Waste within Crater or Potential Crater Areas

This grouping of sites comprises CASs 03-23-02, 03-23-05, and 20-19-01, which include sites where surface or buried waste was disposed within craters or potential crater areas.

A.2.2.1 Corrective Action Site 03-23-02, Waste Disposal Site

Corrective Action Site 03-23-02 was first identified by REECo in 1991 as a posted BURMA, defined by the perimeter of the U-3gi potential crater area, and was subsequently entered into the FFACO as a waste disposal site. Figure A.2-8 shows an aerial view of the CAS and surrounding area. The fenced site is shown in Figure A.2-9.

Physical Setting – The U-3gi potential crater area is associated with the underground nuclear test, Tuloso, conducted on December 12, 1972 in Area 3. Sometime between 1990 and 1998, the potential crater area associated with U-3gi was reposted as an URMA and is currently posted as a CA. The change from URMA to CA was the result of a demarcation survey conducted outside of the perimeter fencing. The U-3gi emplacement borehole casing, which contains communications cables, is located at the center of the fenced area, and two small diameter boreholes (one of which is plugged) are exposed on each side of the emplacement hole. There is no significant observable waste present within the potential crater area (Figure A.2-9); only minimal miscellaneous debris is visible.

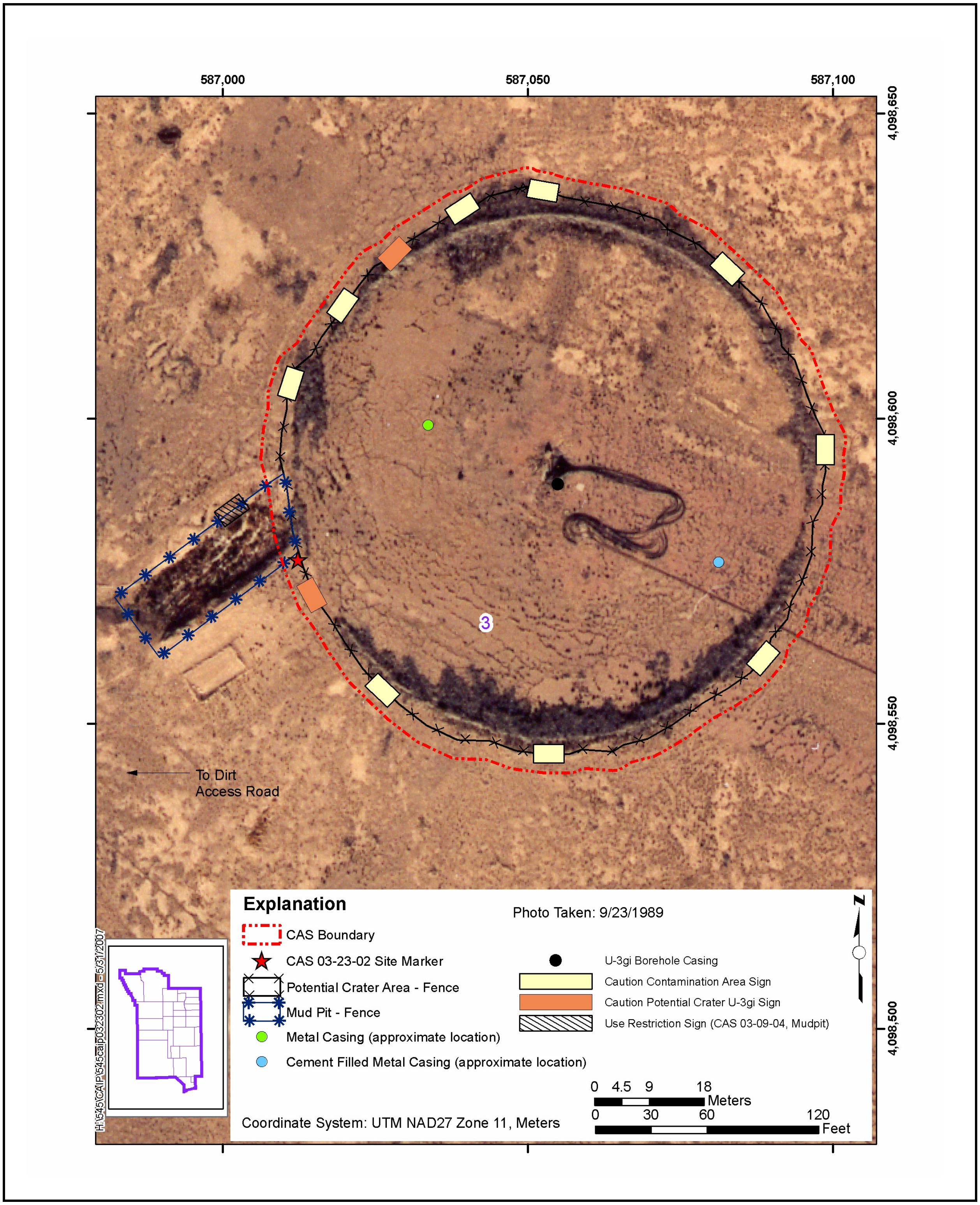

Figure A.2-8
Aerial View of CAS 03-23-02, Waste Disposal Site, and Vicinity

Figure A.2-9
Fenced Area of CAS 03-23-02

Operational History **–** Evidence (i.e., historical documentation, aerial photography, statements, maps and engineering drawings) was not identified to confirm that this site was used for waste storage or disposal purposes. It is believed that this site was placed into the FFACO as a waste disposal site based on the original BURMA postings, which are suspected to have been posted based on the process knowledge that an underground nuclear test was conducted at site U-3gi.

Corrective Action Site 03-23-02 is listed as a high-risk beryllium legacy site (SAIC, 2003; BN, 2004). The document that originally identified the site as a beryllium legacy site (SAIC, 2003) did not provide evidence from samples taken at the site or of operations at the site that beryllium was present. Evidence that beryllium was present at the site was also not identified in any other source reviewed during the site assessment. The Tuloso test conducted at site U-3gi is not listed as a legacy beryllium event (NNSA/NSO, 2007c), and other activities that may have contributed to the potential presence of beryllium at the site were not identified.

Sufficient information exists to conclude that this CAS does not exist as originally identified. In addition, there is no evidence that there has been a release to the environment that would cause an environmental concern. Therefore, there is no environmental concern associated with CAS 03-23-02.

Release Information – There are no identified potential releases of hazardous or radioactive contaminants at CAS 03-23-02. Therefore, additional information is not needed to be able to recommend a no further action corrective action alternative, and DQOs will not be developed for this CAS.

Previous Investigation Results **–** No previous investigations have been identified for this CAS.

A.2.2.2 Corrective Action Site 03-23-05, Europium Disposal Site

Corrective Action Site 03-23-05 consists of two separate components: the release associated with a buried Eu-152 source and a release(s) associated with a buried Pa-233 source sealed a lead pig. Figure A.2-10 shows an aerial view of the CAS and surrounding area. The burial site for the Pa-233 source sealed in a lead pig is shown in Figure A.2-11.

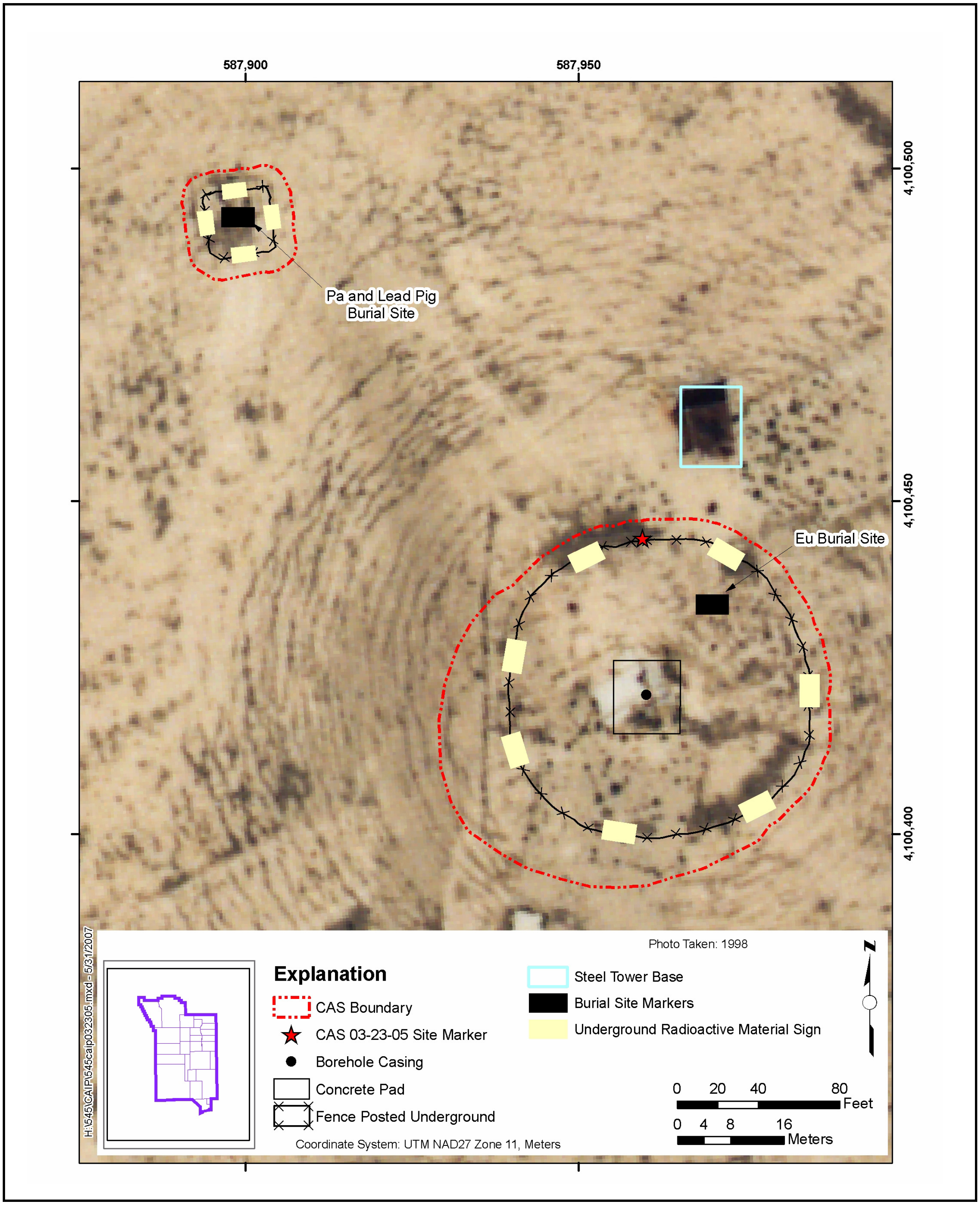

Figure A.2-10
Aerial View of CAS 03-23-05, Europium Disposal Site, and Vicinity

Figure A.2-11
Burial Site for Proactinium-233 Source at CAS 03-23-05
(Portion of Tower in Background)

Physical Setting – Corrective Action Site 03-23-05 consists of two buried radiological sources. The Eu-152 burial site is within the fenced U-3ee potential crater area (posted as an URMA) and is marked by a steel monument. The Eu source is described as being buried under 8 ft of soil and 4 ft of concrete. The actual dimensions of the buried debris are not known. The Pa-233 burial site is located approximately 250 ft outside of the U-3ee potential crater area and is marked by a steel monument within a fenced URMA. The Pa-233 source is sealed in a lead pig, within a "coffin" likely made of steel, and entombed within grout, 8 ft bgs.

Results of a crater stability study at this site indicate that surface subsidence is possible (LANL, date unknown); therefore, the potential crater area in not considered to be safe for entry.

Operational History **–** Corrective Action Site 03-23-05 is associated with the Pommard underground nuclear test, which was conducted on March 14, 1968, and resulted in establishment of the U-3ee potential crater area.

Approximately one week after the Pommard test, a survey was performed on the third floor of the U-3ee tower to determine ambient radiation levels from the Eu source, which was originally located within a LOS pipe on the third floor. Exposure levels ranged from greater than 1,000 R/h on the LOS pipe to 3 R/h average for the general unshielded area. On May 2, 1968, another survey was conducted on the third floor of the U-3ee tower, and on May 7, 1968, the tower was cut between the fourth and fifth levels. On May 9, 1968, the removed third floor was placed into a prepared burial pit approximately 50 ft from the first floor of the tower, and cement was poured into the pit to reduce radiation exposure levels. On May 14 and 16, two more courses of cement were added to the Eu burial pit (REECo, 1968).

On April 4, 1968, the 40-kCi Pa-233 source, expected to have been contained in a lead pig, was reburied in a "strengthened coffin" under 2 ft of soil and 6 ft of grout, as the original plywood container was collapsing and the sides of the pit were caving in. The pig was reburied remotely inside of the perimeter fence by the use of cranes. After reburial, the maximum exposure rate on contact with the lid was 140 milliroentgens per hour. For the Pa-233 source the accumulation of U-233 (daughter produce of Pa-233) was calculated making various assumptions, and the amount resulting from radioactive decay of Pa-233 is approximately 18.7 mCi (or 1.93 grams) (Niven, 2007), which meets Special Nuclear Material values according to DOE Manual 470.4-6 (DOE, 2005).

Release Information – There is the potential for an environmental release associated with the buried Eu-152 and Pa-233 sources. If containment of the sources were to fail, lead, gamma emitters, and U-233 (which is the progeny from the rapid decay of Pa-233 [e.g., half life = 27.0 days]) could be released.

Previous Investigation Results – No previous investigations have been identified for this CAS.

A.2.2.3 Corrective Action Site 20-19-01, Waste Disposal Site

Corrective Action Site 20-19-01 consists of the release(s) associated with surface waste/debris located within the perimeter of the U-20p potential crater area, just beyond a mud pit, (CAU 544, CAS 20-09-03). Figure A.2-12 shows an aerial view of the CAS and surrounding area.

Physical Setting – Corrective Action Site 20-19-01 consists of the releases associated with an approximately 50-by-25-ft area of surface waste/debris, which includes lumber, tin cans, metal and wood cable spools, and some glass, cables, and other deteriorating materials (e.g, rubber boots, plastic, insulation) (Figure A.2-13). The waste is located within the U-20p potential crater area, which is in a remote location in the northwest portion of Area 20 on Pahute Mesa.

The U-20p area is fenced and posted as a potential crater area. A crater stability study at U-20p concluded that the current configuration is stable; thus, the potential crater area is considered to be safe for entry.

Operational History – Surface waste/debris at CAS 20-19-01 is believed to have been generated and disposed during testing activities at U-20p, which was the site of the Stilton underground test conducted on June 3, 1975. Several drums located at this site were removed in 1991 during housekeeping activities of CAS 20-22-03, Drums, in CAU 523. No other specific activities associated with waste disposal at CAS 20-19-01 are known.

Release Information – There is a potential for an environmental release associated with the surface waste and debris. The underlying soil is potentially impacted by chemical or radiological contamination based on process knowledge and operational history.

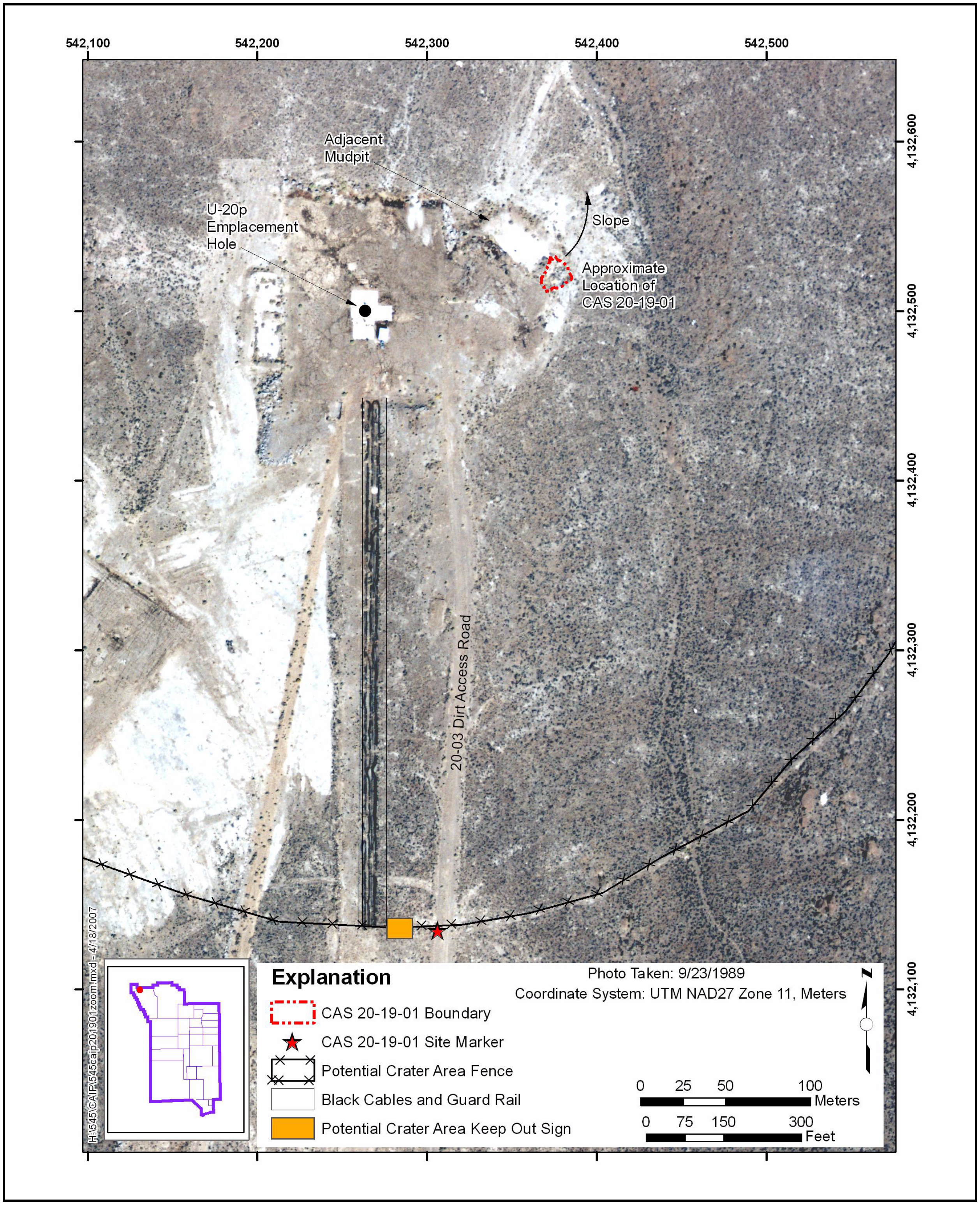

Figure A.2-12
Aerial View of CAS 20-19-01, Waste Disposal Site, and Vicinity

Figure A.2-13
Waste Disposal Site and Side of Adjacent Mudpit, CAS 20-19-01

Previous Investigation Results – Previous corrective action activities were completed on September 9, 1991, for CAS 20-22-03, Drums, in CAU 523, at the area that includes CAS 20-19-01 (REECo, 1992). These activities involved the removal of three drums from the site and photo-documentation to verify the drums had been removed. In the Closure Report for CAU 523, a visual verification was made that the drums were not present (NNSA/NSO, 2003). No soil samples appear to have been taken, and the remaining debris was left at the site due to inaccessibility for vehicles and worker safety. No further action was required for CAS 20-22-03.

A.2.3 Group 3: CASs Associated with Surface and/or Buried Waste, Not within Craters

This grouping of sites (CASs 03-17-01 and 03-99-14) comprises sites where surface or buried waste was disposed, but where the physical setting is not within craters or potential crater areas.

A.2.3.1 Corrective Action Site 03-17-01, Waste Consolidation Site 3B

Corrective Action Site 03-17-01 consists of the releases associated with surface debris that was formerly stored within two separate fenced areas, located in Area 3. Figure A.2-14 shows an aerial view of the CAS and surrounding area. The circular area (foreground) and large rectangular area (background) are shown in Figure A.2-15.

Physical Setting – Waste Consolidation Site 3B includes a large rectangular fenced area that measures 950 by 750 ft and an adjacent circular fenced area to the west that measures 145 ft in diameter. Fencing consists of chicken wire and twisted wire, and “Caution Contamination Area” postings are present on the north, east, and west sides of the site. Both fenced areas are heavily vegetated and contain minimal surface debris. A gravel pile that measures 45 by 10 ft is located at the south side of the site and is not expected to have an impact on the CAS. A dirt access road continues around the perimeter of the site.

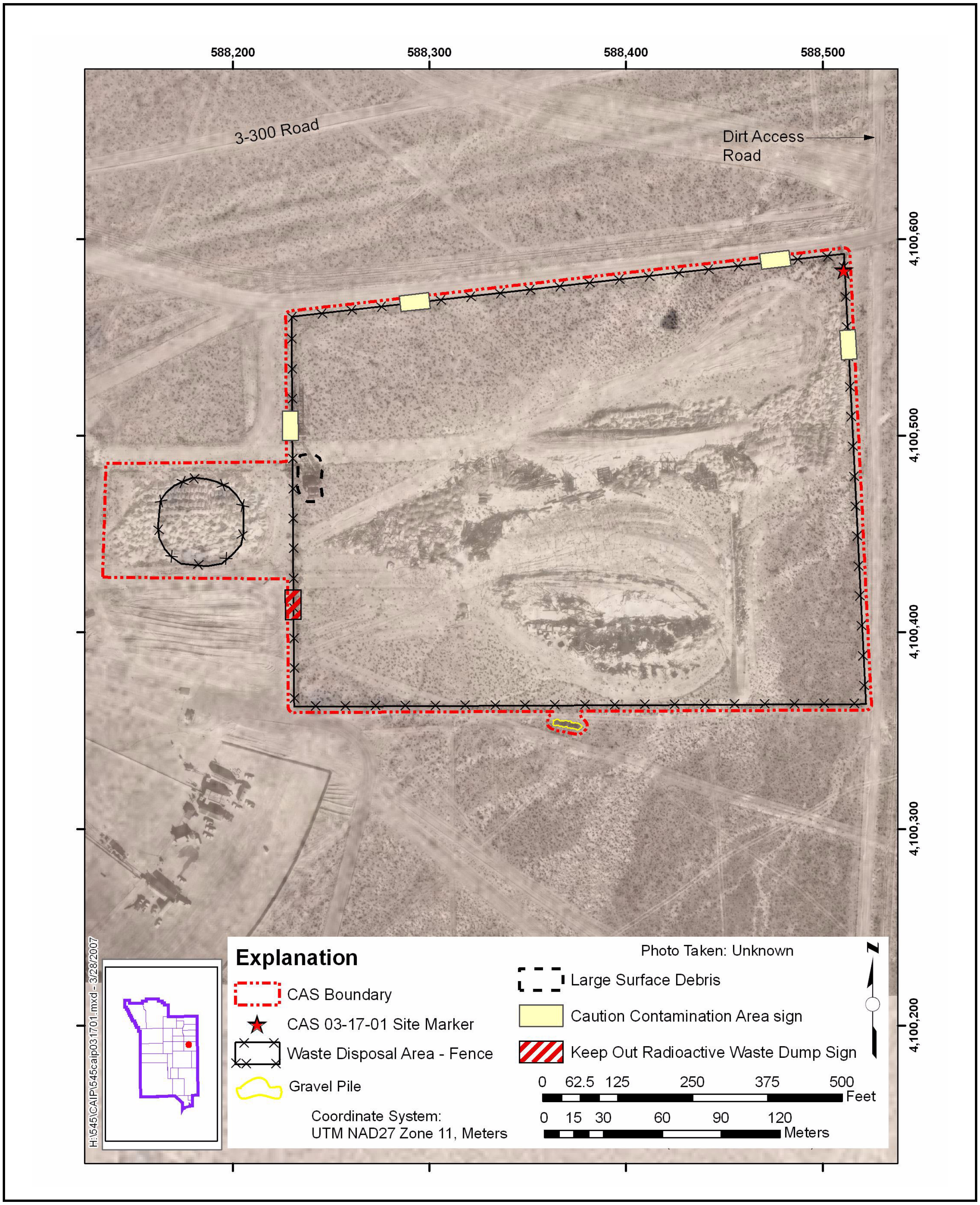

Figure A.2-14
Aerial View of CAS 03-17-01, Waste Consolidation Site 3B, and Vicinity

Figure A.2-15
Circular Component (Foreground) and Rectangular Component (Background), CAS 03-17-01

Operational History – This waste consolidation site was part of a program aimed at the consolidation of radioactive waste materials, such as soil and debris, which were associated with nearby atmospheric tests. Historical documentation indicates that the site was in operation as early as 1959 and that materials stored included 42,000 yd^3 of soil, 200 yd^3 of concrete debris, 290 tons of steel and cable, and 5,000 board ft of lumber (REECo, 1983). Cleanup of the site, in which approximately 40,000 yd^3 of contaminated material was moved to the Area 3 RWMS for final disposal, began in 1986 and was completed by May 29, 1987, as part of the NTS Radioactive Waste Consolidation Project (Neagle and Horton, 1987). Aerial photography shows that by 1987, all waste was removed, and the ground surface of the rectangular and circular fenced areas were graded (EG&G/RSL, 1987).

Release Information – There is the potential for an environmental release associated with the former storage of potentially radioactive materials associated with various atmospheric test sites. Although the site was cleaned and closed, the soil at CAS 03-17-01 may be impacted by radiological contamination, based on process knowledge and operational history.

Previous Investigation Results – Soil at Waste Consolidation Site 3B was sampled over two time periods from 1986 to 1987, during and after cleanup activities at the site, respectively (Neagle and Horton, 1987). Details of the sampling activities, including the numerical values for the analytical radiological results, were not presented in the Waste Consolidation Plan Completion Report. Some of the first round of samples collected at the site had radiological results above ambient levels. Cleanup was completed on May 29, 1987, and the postcleanup soil sample results showed extremely low levels of activities (below 1.3×10^{-3} of Pu-239 and 1.8×10^{-4} of Sr-90 per gram of soil; units for activities were not stated). Also included in the report was information about the operation of two M-102 air samplers, which did not detect alpha or gamma activities above acceptable levels during cleanup activities (Neagle and Horton, 1987).

Geophysical survey results of the rectangular and circular fenced areas, shown in Figure A.2-16, identified 101 discrete anomalies (targets), interpreted to represent subsurface metal objects. Rodent traps found throughout the site, mostly at the surface, are possibly related to these subsurface metal objects. The central portion of the rectangular fenced area contains the bulk of the targets, some of which may be terrain induced by the variable ground surface (i.e., very soft sand, abundant desert brush, and animal burrows) (Weston, 2006).

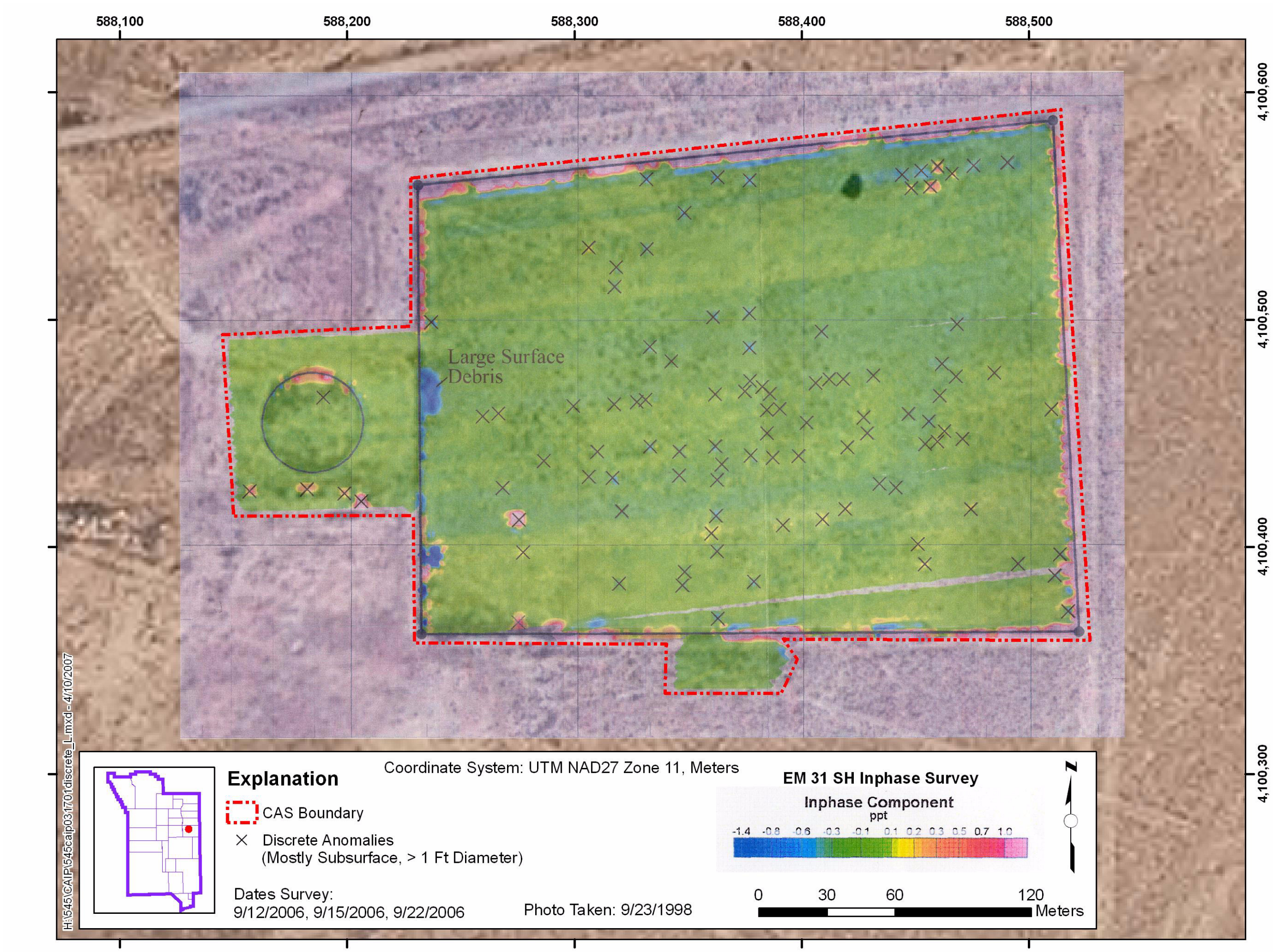

Figure A.2-16
Geophysical Survey Results for CAS 03-17-01

A radiological walkover survey was conducted within the rectangular fenced area, and the results indicate that gamma emission rate for this site was within three times the background rate.

A.2.3.2 Corrective Action Site 03-99-14, Radioactive Material Disposal Area

Corrective Action Site 03-99-14 consists of the releases associated with potential buried waste/debris within a 350-ft-long berm and adjacent trench located in Area 3, just north of the U-3bj crater. Figure A.2-17 shows an aerial view of the CAS and surrounding area. The berm and trench are shown in Figure A.2-18.

Physical Setting – The site includes a linear soil berm that measures 350 by 10 ft and an adjacent excavated trench that measures 350 by 3 ft located near the south shoulder of 3-14 Road. The berm/trench are located within a posted "Caution Radioactive Material" area; however, these postings are present all along the north and south sides of 3-14 Road and are not expected to be associated solely with the CAS. The berm consists of what appears to be native soil, and the trench is approximately 3 ft deep and filled with tumbleweeds. An active air monitoring station that is powered by solar panels is located adjacent to the berm/trench but is not within the scope of the CAS.

Operational History – The activities associated with formation of the berm/trench are unknown; however, it is possible that they were formed and/or used during operations at U-3bj, which was the site of the Bandicoot underground test conducted on October 19, 1962. Aerial photographs show that the berm/trench were present as early as 1989, but the actual date of construction is unknown. It is possible that the berm is the result of excavation of the trench, and that this site was not used as planned; however, this is an uncertainty.

Release Information – There is a potential for an environmental release associated with potential buried waste/debris within the berm/trench. A release may include chemical or radiological contaminants because the type of buried material is unknown.

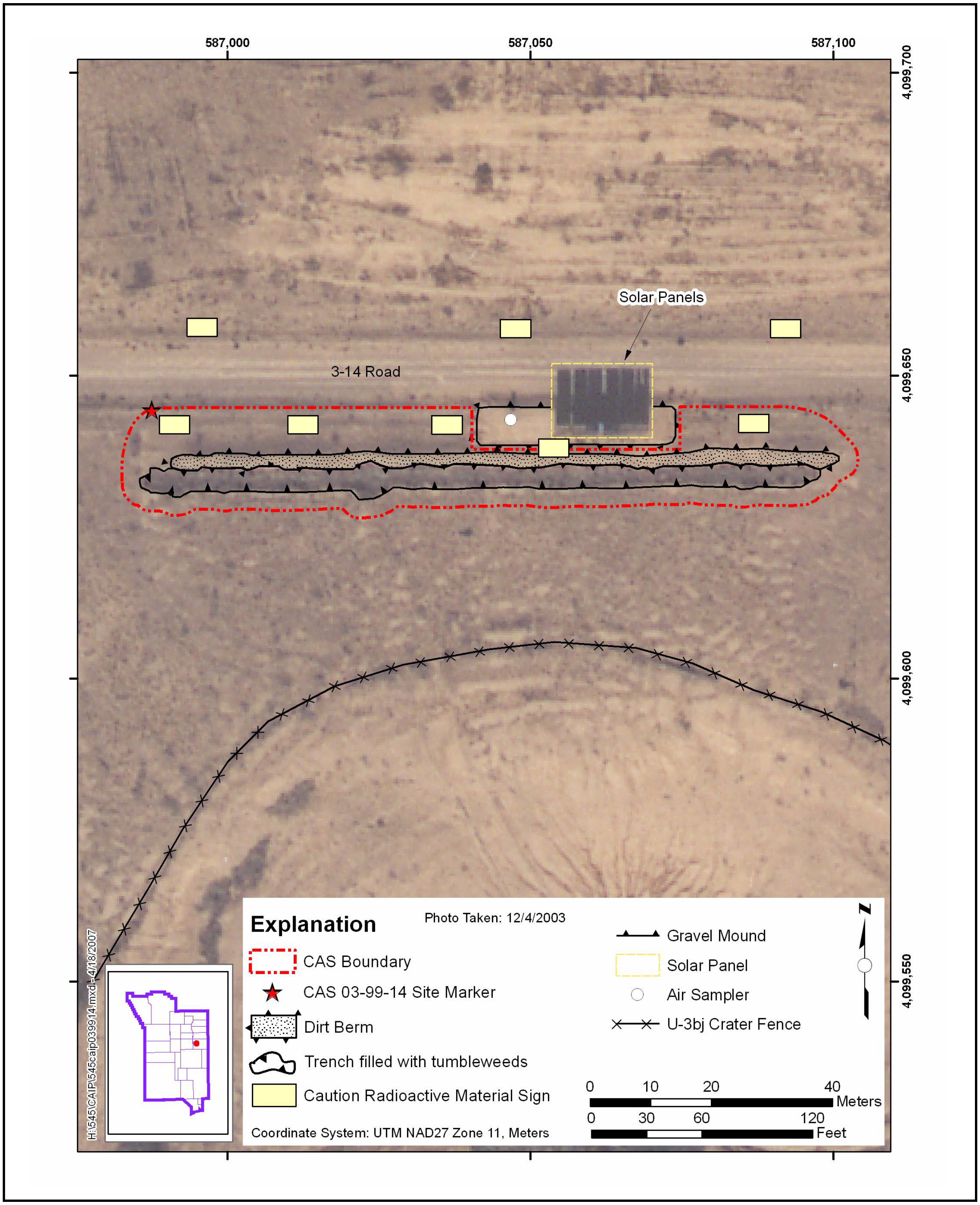

Figure A.2-17
Aerial View of CAS 03-99-14, Radioactive Material Disposal Area, and Vicinity

Figure A.2-18
Berm and Trench, CAS 03-99-14 (Solar Panels in Background)

Corrective Action Site 03-99-14 is located within the radiological plume (Soils CAS 03-23-10) associated with the T3 atmospheric test site, which was the location of several atmospheric tests conducted between 1953 and 1955 that resulted in the creation of Trinity glass throughout the area (Figure A.2-19). Figure A.2-19 shows that CAS 03-99-14 is located within the 9 to 27 μR/h contour interval and within a Trinity glass dispersion boundary. It is therefore possible to encounter elevated radioactivity at CAS 03-99-14 due to nearby atmospheric testing (Soils CAS 03-23-10), not associated with a release from CAS 03-99-14.

Previous Investigation Results – No previous investigations have been identified for this CAS.

A.2.4 CAS Summary

Corrective Action Sites 02-09-01, 03-17-01, 03-99-14, 09-23-02, and 20-19-01 are comprised of potential releases of hazardous and/or radioactive contaminants. Other than the following CASs, additional information is needed on the nature and extent of potential contamination at these sites to be able to evaluate and recommend appropriate corrective action alternatives:

- For CAS 03-08-03, though the potential for subsidence of the craters was judged to be extremely unlikely (LANL, date unknown), the DQO meeting participants agreed that sufficient information existed about disposal and releases at the site and that a corrective action of close in place with a use restriction is recommended. Sampling in the craters will not be necessary.

- For CAS 03-23-02, there are no identified potential releases of hazardous or radioactive contaminants. Therefore, no additional information is needed to recommend a no further action corrective action alternative, and DQOs will not be developed for this CAS.

- For CAS 03-23-05, existing information about the two buried sources and lead pig is sufficient, and safety concerns exist about the stability of the crater component. Therefore, a corrective action of close in place with a use restriction is recommended, and sampling at the site will not be necessary.

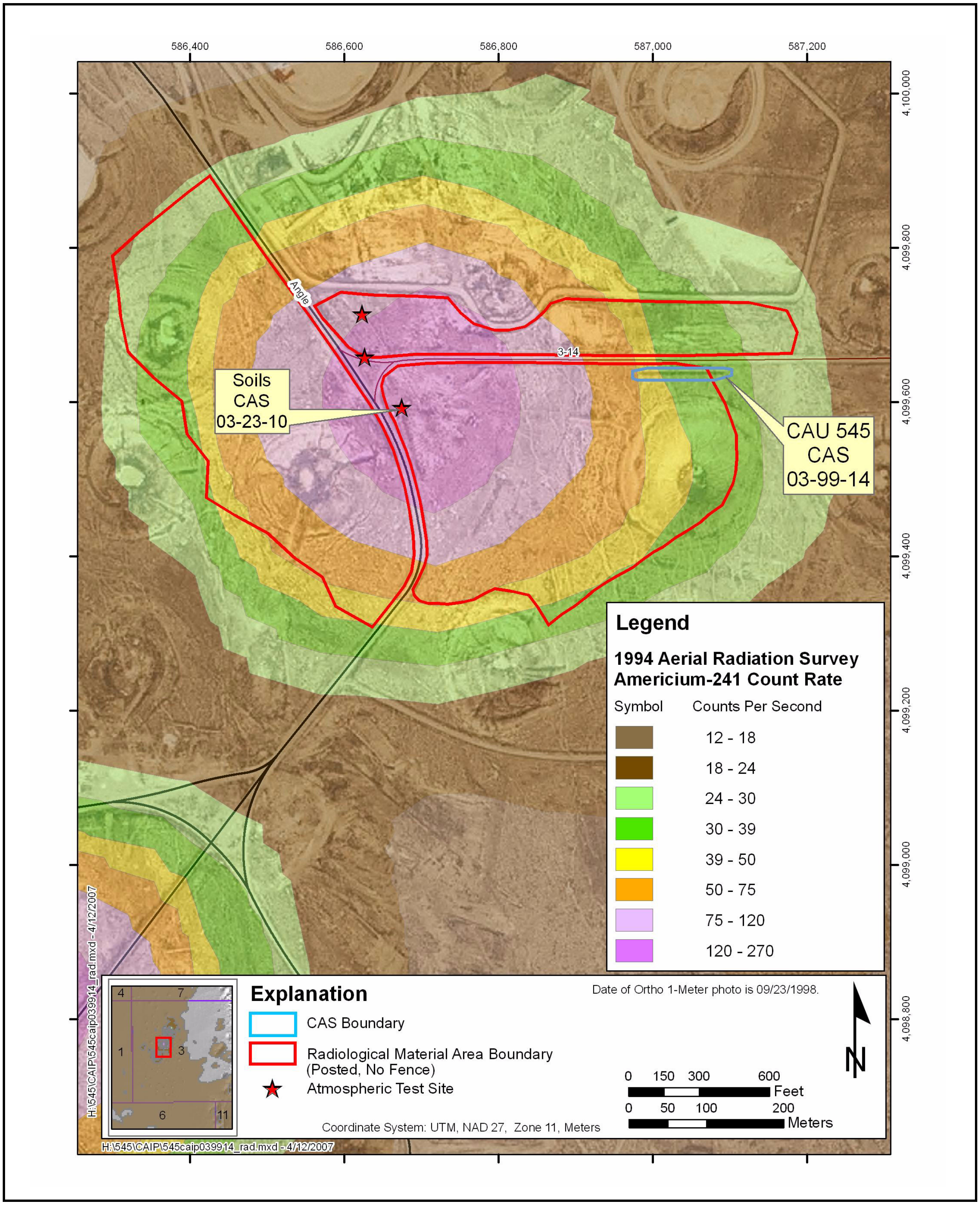

Figure A.2-19
Radiological Isopleths for CAS 03-99-14 and Vicinity, 1994 Flyover Survey

A.3.0 Step 1 - State the Problem

Step 1 of the DQO process defines the problem that requires study identifies the planning team, and develops a conceptual model of the environmental hazard to be investigated.

The problem statement for CAU 545 is: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for the CASs in CAU 545."

A.3.1 Planning Team Members

The DQO planning team consists of representatives from NDEP, NNSA/NSO, SNJV, and NSTec. The DQO planning team met on February 28, 2007, for the DQO meeting. The primary decision makers are the NDEP and NNSA/NSO representatives.

A.3.2 Conceptual Site Model

The CSM is used to organize and communicate information about site characteristics. It reflects the best interpretation of available information at any point in time. The CSM is a primary vehicle for communicating assumptions about release mechanisms, potential migration pathways, or specific constraints. It provides a good summary of how and where contaminants are expected to move, and what impacts such movement may have. It is the basis for assessing how contaminants could reach receptors both in the present and future. The CSM describes the most probable scenario for current conditions at each site and defines the assumptions that are the basis for identifying appropriate sampling strategy and data collection methods. Accurate CSMs are important, as they serve as the basis for all subsequent inputs and decisions throughout the DQO process.

The CSM was developed for CAU 545 using information from the physical setting, potential contaminant sources, release information, historical background information, knowledge from similar sites, and physical and chemical properties of the potentially affected media and COPCs.

The CSM consists of:

- Potential contaminant releases, including media subsequently affected.
- Release mechanisms (the conditions associated with the release).
- Potential contaminant source characteristics including contaminants suspected to be present and contaminant-specific properties.
- Site characteristics including physical, topographical, and meteorological information.
- Migration pathways and transport mechanisms that describe the potential for migration and where the contamination may be transported.
- The locations of points of exposure where individuals or populations may come in contact with a COC associated with a CAS.
- Routes of exposure where contaminants may enter the receptor.

If additional elements are identified during the investigation that are outside the scope of the CSM, the situation will be reviewed, and a recommendation will be made as to how to proceed. In such cases, NDEP will be given the opportunity for input and to comment on the recommendations. Concurrence from the decision makers will be received before continuing the effort.

The applicability of the CSM to each CAS is summarized in Table A.3-1 and discussed below. Table A.3-1 provides information on CSM elements that will be used throughout the remaining steps of the DQO process. Figure A.3-1 represents site conditions applicable to the CSM.

A.3.2.1 Contaminant Release

The most likely locations of the contamination and releases to the environment are the soils directly below or adjacent to the drilling mud and surface and subsurface debris. The CSM accounts for potential releases resulting from migration of contaminants from the source outward to the contiguous environment. Any contaminants migrating from CASs, regardless of physical or chemical characteristics, are expected to exist at interfaces, and in the soil adjacent to disposal features in lateral and vertical directions.

Table A.3-1
Conceptual Site Model
Description of Elements for Each CAS in CAU 545
(Page 1 of 2)

CAS Identifier	**02-09-01**	**03-17-01**	**03-99-14**	**09-23-02**	**20-19-01**
CAS Description	**Mud Disposal Area**	**Waste Consolidation Site 3B**	**Radioactive Material Disposal Area**	**U-9y Drilling Mud Disposal Crater**	**Waste Disposal Site**
Site Status	Sites are inactive and abandoned				
Exposure Scenario	Occasional Use Area				
Sources of Potential Soil Contamination	Released drilling mud	Debris, waste-soil, and/or containers that may have been disposed/stored at site	Buried waste and debris	Released drilling mud	Surface waste and debris
Location of Contamination/ Release Point	Interface between drilling mud and native soil	Interface between debris and native soil at location(s) of disposed/stored waste or materials	Interface between debris and native soil at location(s) of disposed/stored waste or materials	Interface between drilling mud or possible buried materials and native soil	Interface between debris and native soil at location(s) of disposed/stored waste or materials
Amount Released	Unknown				
Affected Media	Surface and shallow subsurface soil	Surface and shallow subsurface soil	Surface and shallow subsurface soil	Surface and shallow subsurface soil	Surface and shallow subsurface soil
Potential Contaminants	Gamma and isotopic radionuclides	RCRA metals, gamma and isotopic radionuclides	VOCs, SVOCs, PCBs, TPH-DRO, RCRA metals, gamma and isotopic radionuclides	VOCs, SVOCs, TPH-DRO, RCRA metals, gamma and isotopic radionuclides	VOCs, SVOCs, PCBs, TPH-DRO, RCRA metals, gamma and isotopic radionuclides

Table A.3-1
Conceptual Site Model
Description of Elements for Each CAS in CAU 545
(Page 2 of 2)

CAS Identifier	02-09-01	03-17-01	03-99-14	09-23-02	20-19-01
CAS Description	Mud Disposal Area	Waste Consolidation Site 3B	Radioactive Material Disposal Area	U-9y Drilling Mud Disposal Crater	Waste Disposal Site
Transport Mechanisms	Surface-water runoff of dissolved or suspended contaminants is the most likely potential transport mechanism for waste materials placed on and in soils at the NTS. The potential for overland migration of contaminants increases with slope gradient and precipitation amount. Infiltration and percolation of precipitation through subsurface media could serve as a major driving force for migration of contaminants. However, due to the arid environment of the NTS, percolation of precipitation is very small and migration of contaminants has been shown to be limited. Evaporation potentials significantly exceed available soil moisture from precipitation (i.e., 6 to 10 inches) (Winograd and Thordarson, 1975).				
Migration Pathways	Lateral transport expected to dominate over vertical transport, except for subsurface releases and within craters				
Lateral and Vertical Extent of Contamination	Contamination, if present, is expected to be contiguous to the release points. Concentrations are expected to decrease with distance and depth from the source. Groundwater contamination is not expected. Lateral and vertical extent of COC contamination is assumed to be within the spatial boundaries.				
Exposure Pathways	The potential for contamination exposure is limited to industrial and construction workers, and military personnel conducting training. These human receptors may be exposed to COPCs through oral ingestion, inhalation, dermal contact (absorption) of soil and/or debris due to inadvertent disturbance of these materials, or irradiation by radioactive materials.				

COC = Contaminant of concern
COPC = Contaminant of potential concern
DRO = Diesel-range organics
NTS = Nevada Test Site
PCB = Polychlorinated biphenyl
RCRA = *Resource Conservation and Recovery Act*
SVOC = Semivolatile organic compound
TPH = Total petroleum hydrocarbons
VOC = Volatile organic compound

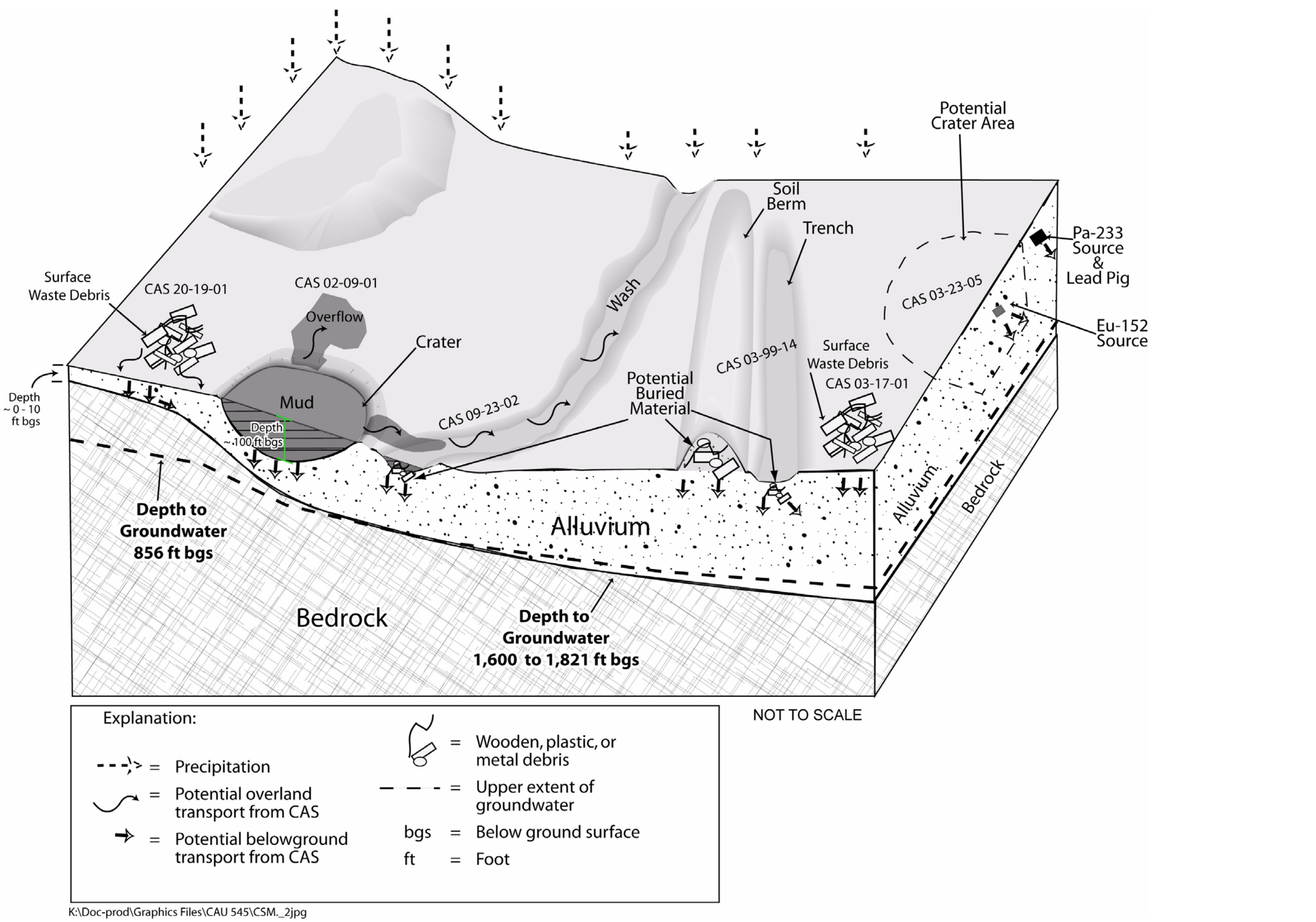

Figure A.3-1
Conceptual Site Model for CAU 545

A.3.2.2 Potential Contaminants

The COPCs were identified during the planning process through the review of site history, process knowledge, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs. Because complete information regarding activities performed at the CAU 545 sites is not available, contaminants detected at similar NTS sites were included in the contaminant lists to reduce uncertainty. The list of COPCs is intended to encompass all of the contaminants that could potentially be present at each CAS. The COPCs applicable to Decision I environmental samples from each of the CASs of CAU 545 are defined as the constituents reported from the analytical methods stipulated in Table A.3-2.

Table A.3-2
Analytical Program[a]
(Includes Waste Characterization Analyses)

Analyses	CAS 02-09-01	CAS 03-17-01	CAS 03-99-14	CAS 09-23-02	CAS 20-19-01
Organic Contaminants of Potential Concern (COPCs)					
Total Petroleum Hydrocarbons-Diesel-Range Organics	--	--	X	X	X
Polychlorinated Biphenyls	--	--	X	--	X
Semivolatile Organic Compounds	--	--	X	X	X
Volatile Organic Compounds	--	--	X	X	X
Inorganic COPCs					
Resource Conservation and Recovery Act Metals	--	X	X	X	X
Radionuclide COPCs					
Gamma Spectroscopy[b]	X	X	X	X	X
Isotopic Uranium	X	X	X	X	X
Isotopic Plutonium	X	X	X	X	X
Strontium-90	X	X	X	X	X

X = Required analytical method

[a]The contaminants of potential concern are the constituents reported from the analytical methods listed.
[b]Results of gamma analysis will be used to determine whether further radioanalytical analysis is warranted.

During the review of site history documentation, process knowledge information, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs, some of the COPCs were identified as targeted contaminants at specific CASs. Targeted contaminants are those COPCs for which evidence in the available site and process information suggests that they may be reasonably suspected to be present at a given CAS. The targeted contaminants are required to meet a more stringent completeness criteria than other COPCs thus providing greater protection against a decision error (see Section 6.2.6). Targeted contaminants for each CAU 545 CAS are identified in Table A.3-3. Once a COPC is detected at a concentration that exceeds the action level, it is also considered a targeted contaminant.

Table A.3-3
Targeted Contaminants for CAU 545

Corrective Action Site	Chemical Targeted Contaminant(s)	Radiological Targeted Contaminant(s)
02-09-01	--	--
03-17-01	--	Am-241, Cs-137, Eu-152, and Isotopic Pu
03-99-14	--	--
09-23-02	--	Am-241, Cs-137, and Isotopic Pu
20-19-01	--	--

Am = Americium
Cs = Cesium
Eu = Europium
Pu = Plutonium

The radionuclides Am-241, Cs-137, Eu-152, Pu-238, and Pu-239 are targeted analytes for CAS 03-17-01 due to the occurrence of radionuclides at similar sites (CASs 01-08-01 and 07-23-02 for CAU 137; CAS 04-08-02 for CAU 139) or else their expected presence in radiologically contaminated waste and debris from atmospheric testing sites (NNSA/NSO, 2007a and b). The radionuclides U-233 (progeny from Pa-233 radioactive decay) and Eu-152, both present as radioactive sources, and the RCRA metal lead, present as the lead pig, are targeted analytes for CAS 03-23-05. The radionuclides Am-241, Cs-137, Pu-238, and Pu-239 are targeted analytes for CAS 09-23-02 due to the posting of the wash component as an URMA. The radionuclide Eu-152 is not targeted for this CAS because no evidence exists that material in the wash came from near ground zero at an atmospheric testing site.

A.3.2.3 Contaminant Characteristics

Contaminant characteristics include, but are not limited to: solubility, density, and adsorption potential. In general, contaminants with low solubility, high affinity for media, and high density can be expected to be found relatively close to release points. Contaminants with small particle size, high solubility, low density, and/or low affinity for media are found further from release points or in low areas where evaporation of ponding will concentrate dissolved contaminants.

A.3.2.4 Site Characteristics

Site characteristics are defined by the interaction of physical, topographical, and meteorological attributes and properties. Physical properties include permeability, porosity, hydraulic conductivity, degree of saturation, sorting, chemical composition, and organic content. Topographical and meteorological properties and attributes include slope stability, precipitation frequency and amounts, precipitation runoff pathways, drainage channels and ephemeral streams, and evapotranspiration potential.

A.3.2.5 Migration Pathways and Transport Mechanisms

Migration pathways include the lateral migration of potential contaminants across surface soils/sediments and vertical migration of potential contaminants through subsurface soils. Contaminants released into a wash, such as the one within CAS 09-23-02, are subject to much higher transport mechanisms than contaminants released to other surface areas. Washes, such as those in the Yucca Flat area, are generally dry but are subject to infrequent, potentially intense, stormwater flows. These stormwater flow events provide an intermittent mechanism for both vertical and horizontal transport of contaminants. Contaminated sediments entrained by these stormwater events would be carried by the streamflow to locations where the flowing water loses energy and the sediments drop out. These locations are identified by hydrologists as sedimentation areas. For example, the sediment traps down gradient from the URMA portion of the wash in CAS 09-23-02 serve as collection points for migrating potentially contaminated sediments.

Infiltration and percolation of precipitation serves as a driving force for downward migration of contaminants. However, due to high potential evapotranspiration (annual potential evapotranspiration at the Area 3 RWMS has been estimated at 62.6 in. [Shott et al., 1997]) and limited precipitation for this region (6 to 10 in./yr [Winograd and Thordarson, 1975]), percolation of infiltrated precipitation at the NTS does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992).

A.3.2.6 Exposure Scenarios

Human receptors may be exposed to COPCs through oral ingestion, inhalation, dermal contact (absorption) of soil or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials. The land-use and exposure scenarios for the CAU 545 CASs are listed in Table A.3-4. These are based on NTS current and future land use. No facilities are present that would allow these CASs to be used as an assigned work station for NTS site personnel. There is still the possibility, however, that site workers could occupy these locations on an occasional and temporary basis such as a military exercise. Therefore, these sites are classified as occasional work areas.

Table A.3-4
Land-Use and Exposure Scenarios

Corrective Action Site	Record of Decision Land-Use Zone	Exposure Scenario
02-09-01, 03-17-01, 03-99-14,	Nuclear and High Explosives Test This area is designated within the Nuclear Test Zone for additional underground nuclear weapons tests and outdoor high-explosive tests. This zone includes compatible defense and nondefense research, development, and testing activities.	Occasional Use Area Worker will be exposed to the site occasionally (up to 80 hours per year for 5 years). Site structures are not present for shelter and comfort of the worker.
09-23-02, 20-19-01	Nuclear Test This area is reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons effects tests. This zone includes compatible defense and nondefense research, development, and testing activities.	Occasional Use Area Worker will be exposed to the site occasionally (up to 80 hours per year for 5 years). Site structures are not present for shelter and comfort of the worker.

A.4.0 Step 2 - Identify the Goal of the Study

Step 2 of the DQO process states how environmental data will be used in meeting objectives and solving the problem, identifies study questions or decision statement(s), and considers alternative outcomes or actions that can occur upon answering the question(s).

A.4.1 Decision Statements

The Decision I statement is: "Is any COC present in environmental media within the CAS?" For judgmental sampling designs, any analytical result for a COPC above the FAL will result in that COPC being designated as a COC. For probability (random) sampling designs, any COPC that has a 95 percent UCL of the average concentration above the FAL will result in that COPC being designated as a COC. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2006). If a COC is detected, then Decision II must be resolved.

The Decision II statement is: "If a COC is present, is sufficient information available to evaluate potential corrective action alternatives?" Sufficient information is defined to include:

- Identifying the volume of media containing any COC bounded by analytical sample results in lateral and vertical directions.
- The information needed to determine potential remediation waste types.
- The information needed to evaluate the feasibility of remediation alternatives (geotechnical data if construction or evaluation of barriers is considered).

A corrective action will be determined for any site containing a COC. The evaluation of the need for corrective action will include the potential for wastes that are present at a site to cause the future contamination of site environmental media if the wastes were to be released. To evaluate the potential for a future release from source material introducing a COC to the surrounding environmental media, the following conservative assumptions were made:

- That waste or debris containing materials that are comprised of contaminants (e.g., lead batteries, fluorescent light bulbs and ballasts, floor tiles, preserved wood) would decompose at some point and release the contaminant(s) to the surrounding media.

- The resulting concentration of contaminants in the surrounding media would be equal to the concentrations in the waste.

If sufficient information is not available to evaluate potential corrective action alternatives then site conditions will be re-evaluated, and additional samples will be collected (as long as the scope of the investigation is not exceeded and any CSM assumption has not been shown to be incorrect).

A.4.2 Alternative Actions to the Decisions

This section identifies the actions that may be taken to solve the problem, depending on the possible outcomes of the investigation.

A.4.2.1 Alternative Actions to Decision I

If no COC associated with a release from the CAS is detected, then further assessment of the CAS is not required. If a COC associated with a release from the CAS is detected, then the extent of COC contamination will be determined, and additional information required to evaluate potential corrective action alternatives will be collected.

A.4.2.2 Alternative Actions to Decision II

If sufficient information is available to evaluate potential corrective action alternatives, then further assessment of the CAS is not required. If sufficient information is not available to evaluate potential corrective action alternatives, then additional samples will be collected.

A.5.0 Step 3 - Identify Information Inputs

Step 3 of the DQO process identifies the information needed, determines sources for information, and identifies sampling and analysis methods that will allow reliable comparisons with FALs.

A.5.1 Information Needs

To resolve Decision I (determine whether a COC is present at a given CAS), samples need to be collected and analyzed following these two criteria:

- Samples must either (a) be collected in areas most likely to contain a COC (judgmental sampling) or (b) properly represent contamination at the CAS (probabilistic sampling)
- The analytical suite selected must be sufficient to identify any COCs present in the samples.

To resolve Decision II (determine whether sufficient information is available to evaluate potential corrective action alternatives at each CAS), samples need to be collected and analyzed to meet the following criteria:

- Samples must be collected in areas contiguous to the contamination but where contaminant concentrations are below FALs.
- Samples of the waste or environmental media must provide sufficient information to determine potential remediation waste types.
- Samples of waste or debris that may contain contaminant(s) to provide sufficient information to determine whether they contain potential source material
- The analytical suites selected must be sufficient to detect contaminants at concentrations equal to or less than their corresponding FALs.

A.5.2 Sources of Information

Information to satisfy Decision I and Decision II will be generated by collecting environmental samples using grab sampling, hand auguring, backhoe excavation, or other appropriate sampling methods. These samples will be submitted to analytical laboratories meeting the quality criteria stipulated in the Industrial Sites QAPP (NNSA/NV, 2002a). Only validated data from analytical laboratories will be used to make DQO decisions. Sample collection and handling activities will follow standard procedures.

A.5.2.1 Sample Locations

Design of the sampling approaches for the CAU 545 CASs must ensure that the data collected are sufficient for selection of the corrective action alternatives (EPA, 2002). To meet this objective, the samples collected from each site should either be from locations that most likely contain a COC, if present (judgmental), or from sites that properly represent overall contamination at the CAS. These sample locations, therefore, can be selected by means of either (a) biasing factors used in judgmental sampling (e.g., a stain, likely containing a spilled substance) or (b) a probabilistic sampling design. Because the information available to develop judgmental sampling varies in scope among the CAU 545 CASs, both judgmental and probabilistic sampling approaches are used for the CAI. A judgmental sampling design has been developed for CASs 02-09-01, 03-99-14, 09-23-02, and 20-19-01 due to the presence and significance of biasing factors. For CAS 03-17-01, a probabilistic sampling design was developed because of an insufficient number of significant biasing factors; however, five additional judgmental locations will be selected at the most prominent anomalies detected in the geophysical survey. Although some randomly chosen locations may be specified at CASs 09-23-02 and 20-19-01 if biasing factors are absent, the sampling approach is judgmental.

The implementation of a judgmental approach for sample location selection, and of a probabilistic sampling approach, for CAU 545 are discussed in the following sections. Appendix C lists the sample size and locations as calculated by the VSP software program, including the values established as input for selecting random sample locations (PNNL, 2005).

A.5.2.1.1 Judgmental Approach for Sampling Location Selection

Decision I sample locations at CASs 02-09-01, 03-17-01, 03-99-14, 09-23-02, and 20-19-01 will be determined based upon the likelihood of the soil containing a COC, if present at the CAS. These locations will be selected based on field-screening techniques, biasing factors, the CSM, and existing information. Analytical suites for Decision I samples will include all COPCs identified in Table A.3-2.

Field-screening techniques may be used to select appropriate sampling locations by providing semiquantitative data that can be used to comparatively select samples to be submitted for laboratory analyses from several screening locations. Field screening may also be used for health and safety monitoring and to assist in making certain health and safety decisions. The following field-screening method may be used to select analytical samples at CAU 545:

- Walkover surface area radiological surveys – A radiological survey instrument will be used over approximately 100 percent of accessible CAS areas, as permitted by terrain and field conditions, to detect areas of elevated radiological readings.

Biasing factors may also be used to select samples to be submitted for laboratory analyses based on existing site information and site conditions discovered during the investigation. The following factors will also be considered in selecting locations for analytical samples at CAU 545:

- Documented process knowledge on source and location of release (e.g., volume of release).
- Stains: Any spot or area on the soil surface that may indicate the presence of a potentially hazardous liquid. Typically, stains indicate an organic liquid such as an oil has reached the soil, and may have spread out vertically and horizontally.
- Elevated radiation: Any location identified during radiological surveys that had alpha/beta/gamma levels significantly higher than surrounding background soil.
- Geophysical anomalies: Any location identified during geophysical surveys that had results indicating surface or subsurface materials existed, and were not consistent with the natural surroundings (e.g., buried concrete or metal, surface metallic objects).
- Drums, containers, equipment or debris: Materials of interest that may have been used at, or added to, a location, and that may have contained or come in contact with hazardous or radioactive substances at some point during their use.
- Lithology: Locations where variations in lithology (soil or rock) indicate that different conditions or materials may exist.
- Preselected areas based on process knowledge of the site: Locations for which evidence such as historical photographs, experience from previous investigations, or interviewee’s input, exists that a release of hazardous or radioactive substances may have occurred.
- Preselected areas based on process knowledge of the contaminant(s): Locations that may reasonably have received contamination, selected on the basis of the chemical and/or physical properties of the contaminant(s) in that environmental setting.

- Previous sample results: Locations that may reasonably have been contaminated based upon the results of previous field investigations.
- Experience and data from investigations of similar sites.
- Visual indicators such as discoloration, textural discontinuities, disturbance of native soils, or any other indication of potential contamination.
- Odor.
- Physical and chemical characteristics of contaminants.
- Other biasing factors: Factors not previously defined for the CAI, but become evident once the investigation of the site is under way.

Decision II sample step-out locations will be selected based on the CSM, biasing factors, and existing data if applicable. Analytical suites will include those parameters that exceeded FALs (i.e., COCs) in prior samples. Biasing factors to support Decision II sample locations include Decision I biasing factors plus available analytical results.

A.5.2.1.2 Probabilistic Approach for Determination of Sample Size and Location

Resolution of the DQO Decision I associated with the probabilistic sampling design requires determining, with a specified degree of confidence, whether the true average contaminant concentrations at the site in question exceed their corresponding FALs. The averages from sample analytical results for each constituent are an estimation of the true average contaminant concentrations. Because the average contaminant concentrations from samples is only an estimate of the true (unknown) average contaminant concentrations, it is uncertain how well the sample averages represent the true averages. If an average contaminant concentration was directly compared to the FAL, a significant difference between the true average and the sample average could lead to making decision errors. To reduce the probability of making a false negative decision error, a conservative estimate of the true average is used to compare to the FAL. This conservative estimate (overestimation) of the true contaminant concentration averages will be calculated as the 95 percent UCLs of the respective sample contaminant concentration averages. By definition, there will be a 95 percent probability that the true average concentration is less than the 95 percent UCL of the sample average.

The calculation and comparison of UCLs to FALs will be conducted for all significant COPCs. A significant COPC is defined as any contaminant detected in any sample from the CAS at a concentration exceeding its corresponding PAL.

Computation of UCL

The computation of appropriate UCLs depends upon the data distribution, the number of samples, the variability of the dataset, and the skewness associated with the dataset. A statistical package will be used to determine the appropriate probability distribution (e.g., normal, lognormal, gamma) and/or a suitable nonparametric distribution-free method and then to compute appropriate UCLs. To ensure that the appropriate UCL computational method is used, the sample data will be tested for goodness-of-fit to all of the parametric and nonparametric UCL computation methods described in the EPA guidance document *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (OSWER, 2002).

Computation of an appropriate UCL for each of the significant COPCs requires that:

- A minimum number of samples be collected from random locations at each site
- The data originate from a symmetric, but not necessarily normally distributed, population.
- The estimation of the variability is reasonable and representative of the population being sampled.
- The population values are not spatially correlated.

Computation of Minimum Sample Size

The minimum number of samples required to compute a UCL will be calculated from the actual investigation results for each of the significant COPCs to verify that sufficient samples were collected. The VSP software will be used to calculate minimum sample sizes (PNNL, 2005). This software was developed by Pacific Northwest National Laboratory for the DOE and the EPA to determine the minimum number of samples needed to characterize a site based on the type of test to be performed, the distribution of the data, the variability of the data, and the acceptable false positive and false negative error rates.

The input parameters to be used in calculating the minimum sample size are:

- A confidence level that a false negative error will not occur will be set at 95 percent.
- A confidence level that a false positive error will not occur will be set at 80 percent.
- A gray region width of 50 percent of each COPC action level.
- The average concentration or activity of the contaminant
- The standard deviation of the contaminant average concentration or activity

Estimation of Initial Sample Size

Because the minimum number of samples needed to perform the UCL comparison tests cannot be determined until after investigation results are obtained, the number of samples to be collected during the CAI must be estimated. The VSP software will be used to estimate the minimum number of samples needed before the CAI based on estimates and assumptions about the characteristics of the data that will be generated as a result of the CAI (PNNL, 2005). The input parameters used to determine the estimated number of samples required to make DQO decisions are listed in Table A.5-1. Individual CAS probabilistic sampling and analysis designs are discussed in Section A.9.6 (CAS 03-17-01).

Table A.5-1
Parameter Values for Estimating Sample Size

Parameter	Initial Estimate	Final Determination[a]
Sampling Goal	Compare average to final action level	Compare average to final action level
Distribution	Data not assumed to be normally distributed	Best fit distribution determined based on actual data using ProUCL
Hypothesis	Assume site is dirty	Assume site is dirty
False Rejection Rate	5%	5%
False Acceptance Rate	15%	15%
Average	Because no data exist for this site, average was estimated	Determined based on actual data
Standard Deviation	Because no data exist for this site, standard deviation was estimated	Determined based on actual data

[a]Sample size will be calculated for each significant contaminant of potential concern.

These parameters were estimated because no data existed from which to base the estimation of sample size. Therefore, the sufficiency of the number of samples collected will be evaluated following the CAI based on a recalculation of the sample size based on the actual data. For significant COPC analytical results reported as not detected, one-half of the detection limit values will be used to calculate statistical parameters (EPA, 2004a). All calculations for the determination of sample size sufficiency will be provided in the investigation report.

Sample Locations

The location of initial CAI samples will be determined using a triangular grid pattern, based on a starting location that is chosen randomly. If it is determined that additional samples need to be collected based on the determination of minimum sample size using actual sample results, additional sample locations will be determined using the same methodology (for five or more samples) or by randomly selecting each sample location (for less than five samples). The results of the estimated initial sample size calculations and the placement of initial sample locations are presented in Appendix C.

A.5.2.2 Analytical Methods

Analytical methods are available to provide the data needed to resolve the decision statements. The analytical methods and laboratory requirements (e.g., detection limits, precision, and accuracy) are provided in Tables 3-4 and 3-5.

A.6.0 Step 4 - Define the Boundaries of the Study

Step 4 of the DQO process defines the target population of interest and its relevant spatial boundaries, specifies temporal and other practical constraints associated with sample/data collection, and defines the sampling units on which decisions or estimates will be made.

A.6.1 Target Populations of Interest

The population of interest to resolve Decision I ("Is any COC present in environmental media within the CAS?") is either (a) any location within the site that is contaminated with any contaminant above a FAL (judgmental sampling) or (b) locations representative of total site contamination (probabilistic sampling). The populations of interest to resolve Decision II ("If a COC is present, is sufficient information available to evaluate potential corrective action alternatives?") are:

- Each one of a set of locations bounding contamination in lateral and vertical directions to establish the volume of contaminated media
- Potential remediation waste

A.6.2 Spatial Boundaries

Spatial boundaries are the maximum lateral and vertical extent of expected contamination at each CAS, as shown in Table A.6-1. Contamination found beyond these boundaries may indicate a flaw in the CSM and may require re-evaluation of the CSM before the investigation could continue. Each CAS is considered geographically independent and intrusive activities are not intended to extend into the boundaries of neighboring CASs.

A.6.3 Practical Constraints

Practical constraints such as military activities at the NTS, weather (i.e., high winds, rain, lightning, extreme heat), utilities, threatened or endangered animal and plants, unstable or steep terrain, and/or access restrictions may affect the ability to investigate this site. The practical constraints associated with the investigation of the CAU 545 CASs are summarized in Table A.6-2.

Table A.6-1
Spatial Boundaries of CAU 545 CASs

Corrective Action Site	Spatial Boundaries
02-09-01	Laterally, from the three mud disposal areas, at 50 ft, except 500 ft in any wash leaving the site; vertically at 20 ft
03-17-01	Laterally at 50 ft, except 500 ft in any wash leaving the site; vertically at 20 ft
03-99-14	Laterally at 50 ft, except 500 ft in any wash leaving the site; for any wash trending southward, up to the fence surrounding the U-3bj crater; vertically at 20 ft
09-23-02	Laterally at 50 ft, except 500 ft down the wash, which is the primary component being investigated; vertically at 20 ft
20-19-01	Laterally at 50 ft, except 500 ft in any wash leaving the site; vertically at 20 ft

ft = Foot

Table A.6-2
Practical Constraints for the CAU 545 Field Investigation

Corrective Action Site	Practical Constraints
02-09-01	Weather (i.e., high winds, rain, lightning, extreme heat), unfenced (at edge) U-2ei crater (no entry into crater and safety buffer zone due to potential instability), and loose and unconsolidated terrain especially on mud mounds
03-17-01	Weather (i.e., high winds, rain, lightning, extreme heat), and loose and unconsolidated terrain; site is posted “Caution Contamination Area”
03-99-14	Weather (i.e, high winds, rain, lightning, extreme heat); nearby solar panel and air sampler may be impacted by dust generation; U-3bj crater area to immediate south confines equipment access to north (road) side of site; the site is within 1 mile of the Area 3 Radioactive Waste Management Site is posted as a Radioactive Material Area
09-23-02	Weather (i.e., high winds, rain, lightning, warm temperatures), fenced U-9y crater (no entry into crater due to potential instability); and loose and unconsolidated terrain in wash; the crater area is posted “Caution Contamination Area”
20-19-01	Weather (i.e., high winds, snow, rain, lightning, extreme heat), military exercises, remoteness of site impacts accessibility for equipment; Note: U-20p crater encompassing site was deemed stable, so entry is not impacted.

A.6.4 Define the Sampling Units

The scale of decision making in Decision I is defined as the CAS. Any COC detected at any location within the CAS will cause the determination that the CAS is contaminated and needs further evaluation. The scale of decision making for Decision II is defined as a contiguous area contaminated with any COC originating from the CAS. Resolution of Decision II requires this contiguous area to be bounded laterally and vertically.

A.7.0 Step 5 - Develop the Analytic Approach

Step 5 of the DQO process specifies appropriate population parameters for making decisions, defines action levels, and generates an “If … then … else” decision rule that involves it.

A.7.1 Population Parameters

For judgmental sampling results, the population parameter is the observed concentration of each contaminant from each individual analytical sample. Each sample result will be compared to the FALs to determine the appropriate resolution to Decision I and Decision II. For Decision I, a single sample result for any contaminant exceeding a FAL would cause a determination that a COC is present within the CAS.

For probabilistic sampling results, the population parameter is the UCL of the sample population average concentration of each detected contaminant from all analytical samples from an individual contaminant release. The population parameter will be compared to the corresponding FALs to determine the appropriate resolution to Decision I and Decision II. For Decision I, a 95 percent UCL of the mean concentration for any contaminant exceeding a FAL would cause a determination that a COC is present within the CAS.

The Decision II population parameter is an individual analytical result from a bounding sample. For Decision II, a single bounding sample result for any contaminant exceeding a FAL would cause a determination that the contamination is not bounded.

A.7.2 Action Levels

The PALs presented in this section are to be used for site screening purposes. They are not necessarily intended to be used as cleanup action levels or FALs. However, they are useful in screening out contaminants that are not present in sufficient concentrations to warrant further evaluation and, therefore, streamline the consideration of remedial alternatives. The RBCA process used to establish FALs is described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). This process conforms with NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2006a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2006b) recommends the use of ASTM Method E 1739-95 (ASTM, 1995) to “conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (i.e., FALs) or to establish that corrective action is not necessary.”

This RBCA process defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses:

- Tier 1 evaluation - sample results from source areas (highest concentrations) are compared to action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the CAIP). The FALs may then be established as the Tier 1 action levels, or the FALs may be calculated using a Tier 2 evaluation.

- Tier 2 evaluation - conducted by calculating Tier 2 SSTLs using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 SSTLs are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. Total TPH concentrations will not be used for risk-based decisions under Tier 2 or Tier 3. Rather, the individual chemicals of concern will be compared to the SSTLs.

- Tier 3 evaluation - conducted by calculating Tier 3 SSTLs on the basis of more sophisticated risk analyses using methodologies described in Method E1739-95 that consider site-, pathway-, and receptor-specific parameters.

The comparison of laboratory results to FALs and the evaluation of potential corrective actions will be included in the investigation report. The FALs will be defined (along with the basis for their definition) in the investigation report.

A.7.2.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the EPA Region 9 PRGs for chemical contaminants in industrial soils (EPA, 2004b). Background concentrations for RCRA metals and zinc will be used instead of PRGs when natural background concentrations exceed the PRG, as is often the case with arsenic on the NTS. Background is considered the average concentration plus two standard deviations of the average concentration for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999). For detected chemical COPCs without established PRGs, the protocol used by the EPA Region 9 in establishing PRGs (or similar) will be used to establish PALs. If used, this process will be documented in the investigation report.

A.7.2.2 Total Petroleum Hydrocarbons PALs

The PAL for TPH is 100 ppm as listed in NAC 445A.2272 (NAC, 2006c).

A.7.2.3 Radionuclide PALs

The PALs for radiological contaminants (other than tritium) are based on the NCRP Report No. 129 recommended screening limits for construction, commercial, industrial land-use scenarios (NCRP, 1999) scaled to 25 mrem/yr dose constraint (Murphy, 2004) and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993). These PALs are based on the construction, commercial, and industrial land-use scenario provided in the guidance and are appropriate for the NTS based on future land-use scenarios as presented in Table A.3-4. The PAL for tritium is based on the UGTA Project limit of 400,000 pCi/L for discharge of water containing tritium (NNSA/NV, 2002b).

Solid media such as concrete and/or structures may pose a potential radiological exposure risk to site workers if contaminated. The radiological PAL for solid media will be defined as the unrestricted-release criteria defined in the NV/YMP RadCon Manual (NNSA/NSO, 2004b).

A.7.3 Decision Rules

The decision rules applicable to both Decision I and Decision II are:

- If COC contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in Section A.6.2, then work will be suspended and the investigation strategy will be reconsidered, or else the decision will be to continue sampling to define the extent.

The decision rules for Decision I are:

- If the population parameter of any COPC in the Decision I population of interest (defined in Step 4) exceeds the corresponding FAL, then that contaminant is identified as a COC, and Decision II samples will be collected, or else no further investigation is needed for that COPC in that population.

- If a COC exists at any CAS, then a corrective action will be determined, or else no further action will be necessary.
- If a waste is present that, if released, has the potential to cause the future contamination of site environmental media, then a corrective action will be determined, or else no further action will be necessary.

The decision rules for Decision II are:

- If the population parameter (the observed concentration of any COC) in the Decision II population of interest (defined in Step 4) exceeds the corresponding FAL in any bounding direction, then additional samples will be collected to complete the Decision II evaluation, or else the extent of the COC contamination has been defined.
- If valid analytical results are available for the waste characterization samples defined in Section A.9.0, then the decision will be that sufficient information exists to determine potential remediation waste types and evaluate the feasibility of remediation alternatives, or else collect additional waste characterization samples.

A.8.0 Step 6 - Specify Performance or Acceptance Criteria

Step 6 of the DQO process defines the decision hypotheses, specifies controls against false rejection and false acceptance decision errors, examines consequences of making incorrect decisions from the test, and places acceptable limits on the likelihood of making decision errors.

A.8.1 Decision Hypotheses

The baseline condition (i.e., null hypothesis) and alternative condition for Decision I are:

- Baseline condition – A COC is present.
- Alternative condition – A COC is not present.

The baseline condition (i.e., null hypothesis) and alternative condition for Decision II are as follows:

- Baseline condition – The extent of a COC has not been defined.
- Alternative condition – The extent of a COC has been defined.

Decisions and/or criteria have false negative or false positive errors associated with their determination. The impact of these decision errors and the methods that will be used to control these errors are discussed in the following subsections. In general terms, confidence in DQO decisions based on judgmental sampling results will be established qualitatively by:

- Developing and receiving concurrence of CSMs (based on process knowledge) by stakeholder participants during the DQO process;
- Testing the validity of CSMs based on investigation results; and
- Evaluating the data quality based on DQI parameters.

A.8.2 False Negative Decision Error

The false negative decision error would mean deciding that a COC is not present when it actually is (Decision I), or deciding that the extent of a COC has been defined when it has not (Decision II). In both cases the potential consequence is an increased risk to human health and environment.

A.8.2.1 False Negative Decision Error for Judgmental Sampling

In judgmental sampling, the selection of the number and location of samples is based on knowledge of the feature or condition under investigation and on professional judgment (EPA, 2002). Judgmental sampling conclusions about the target population depend upon the validity and accuracy of professional judgment.

The false negative decision error (where consequences are more severe) for judgmental sampling designs is controlled by meeting these criteria:

- For Decision I, having a high degree of confidence that the sample locations selected will identify COCs if present anywhere within the CAS. For Decision II, having a high degree of confidence that the sample locations selected will identify the extent of COCs.
- Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples.
- Having a high degree of confidence that the dataset is of sufficient quality and completeness.

To satisfy the first criterion, Decision I samples must be collected in areas most likely to be contaminated by COCs (supplemented by random samples where appropriate). Decision II samples must be collected in areas that represent the lateral and vertical extent of contamination (above FALs). The following characteristics must be considered to control decision errors for the first criterion:

- Source and location of release
- Chemical nature and fate properties
- Physical transport pathways and properties
- Hydrologic drivers

These characteristics were considered during the development of the CSM and selection of sampling locations. The field-screening methods and biasing factors listed in Section A.5.2.1 will be used to further ensure that appropriate sampling locations are selected to meet these criteria. Radiological survey instruments and field-screening equipment will be calibrated and checked in accordance with the manufacturer’s instructions and approved procedures. The investigation report will present an assessment on the DQI of representativeness that samples were collected from those locations that best represent the populations of interest as defined in Section A.6.1.

To satisfy the second criterion, Decision I samples will be analyzed for the chemical and radiological parameters listed in Section 3.2 of this document. Decision II samples will be analyzed for those chemical and radiological parameters that identified unbounded COCs. The DQI of sensitivity will be assessed for all analytical results to ensure that all sample analyses had measurement sensitivities (detection limits) that were less than or equal to the corresponding FALs. If this criterion is not achieved, the affected data will be assessed (for usability and potential impacts on meeting site characterization objectives) in the investigation report.

To satisfy the third criterion, the entire dataset, as well as individual sample results, will be assessed against the DQIs of precision, accuracy, comparability, and completeness as defined in the Industrial Sites QAPP (NNSA/NV, 2002a) and in Section 6.2.2 of this document. The DQIs of precision and accuracy will be used to assess overall analytical method performance as well as to assess the need to potentially "flag" (qualify) individual contaminant results when corresponding QC sample results are not within the established control limits for precision and accuracy. Data qualified as estimated for reasons of precision or accuracy may be considered to meet the constituent performance criteria based on an assessment of the data. The DQI for completeness will be assessed to ensure that all data needs identified in the DQO have been met. The DQI of comparability will be assessed to ensure that all analytical methods used are equivalent to standard EPA methods so that results will be comparable to regulatory action levels that have been established using those procedures. Strict adherence to established procedures and QA/QC protocol protects against false negatives. Site-specific DQIs are discussed in more detail in Section 6.2.2 of this document.

To provide information for the assessment of the DQIs of precision and accuracy, the following QC samples will be collected as required by the Industrial Sites QAPP (NNSA/NV, 2002a):

- Field duplicates (minimum of 1 per matrix per 20 environmental samples)
- Laboratory QC samples (minimum of 1 per matrix per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected)

A.8.2.2 False Negative Decision Error for Probabilistic Sampling

The false negative error rate for the probabilistic sampling at CAS 03-17-01 is established at 0.05 (or 5 percent probability). Upon validation of the analytical results, statistical parameters will be calculated for each significant COPC identified through the probabilistic approach for the site. Maintenance of a false negative error rate of 0.05 is contingent upon:

- Population distribution
- Sample size
- Actual variability
- Measurement error

Control of the false negative decision error, therefore, for probabilistic sampling designs is accomplished by ensuring that:

- The population distributions fit the applied UCL determination method.
- A sufficient sample size was collected.
- The actual standard deviation is calculated.
- Analyses conducted were sufficient to detect any significant COPC present in samples.

A.8.3 False Positive Decision Error

The false positive decision error would mean deciding that a COC is present when it is not, or a COC is unbounded when it is not, resulting in increased costs for unnecessary sampling and analysis.

False positive results are typically attributed to laboratory and/or sampling/handling errors that could cause cross contamination. To control against cross contamination, decontamination of sampling equipment will be conducted according to established and approved procedures and only clean sample containers will be used. To determine whether a false positive analytical result may have occurred, the following QC samples will be collected as required by the Industrial Sites QAPP (NNSA/NV, 2002a):

- Trip blanks (one per sample cooler containing VOC environmental samples)
- Equipment blanks (one per sampling event for each type of decontamination procedure)
- Source blanks (one per source lot per sampling event)
- Field blanks (minimum of one per CAS, additional if field conditions change)

For probabilistic sampling, the false positive decision error is established at 0.20 (or 20 percent probability). Protection against this decision error is also afforded by the controls listed in Section A.8.2 for probabilistic sampling designs.

A.9.0 Step 7 - Develop the Plan for Obtaining Data

Step 7 of the DQO process selects and documents a design that will yield data that will best achieve performance or acceptance criteria. Judgmental and probabilistic sampling schemes will be implemented to select sample locations and evaluate analytical results for CAU 545. Sections A.9.1 through A.9.3 contain general information about collecting Decision I and Decision II samples under judgmental and probabilistic sampling designs, while the subsequent sections provide CAS-specific sampling activities, including proposed sample locations.

A.9.1 Judgmental Sampling

A judgmental sampling design will be implemented for CASs 02-09-01, 03-99-14, 09-23-02, and 20-19-01. Because individual sample results, rather than an average concentration, will be used to compare to FALs at the CASs undergoing judgmental sampling, statistical methods to generate site characteristics will not be used. Adequate representativeness of the entire target population may not be a requirement to developing a sampling design. If good prior information is available on the target site of interest, then the sampling may be designed to collect samples only from areas known to have the highest concentration levels on the target site. If the observed concentrations from these samples are below the action level, then a decision can be made that the site contains safe levels of the contaminant without the samples being truly representative of the entire area (EPA, 2006).

All sample locations will be selected to satisfy the DQI of representativeness in that samples collected will best represent the populations of interest as defined in Section A.6.1. To meet this criterion, a judgmental sampling strategy will be used for Decision I samples to target areas with the highest potential for contamination, if it is present anywhere in the CAS. Sample locations will be determined based on process knowledge, previously acquired data, or the field-screening and biasing factors listed in Section A.5.2.1. If biasing factors are present in soils below locations where Decision I samples were removed, additional Decision I soil samples will be collected at depth intervals selected by the Site Supervisor based on biasing factors to a depth where the biasing factors are no longer present. The Site Supervisor has the discretion to modify the judgmental sample locations, but only if the modified locations meet the decision needs and criteria stipulated in this DQO.

A.9.2 Probabilistic Sampling

A probabilistic sampling scheme will be implemented to select sample locations and evaluate analytical results at CAS 03-17-01. For probabilistically sampled sites, randomly selected sample locations will be chosen, with locations specified by the VSP software (PNNL, 2005). If a location contains a shallow, hard object (e.g., rock, caliche or buried concrete) the Site Supervisor will establish the location at the nearest place that a surface sample can be obtained.

In addition to the probabilistic sampling at CAS 03-17-01, judgmental locations may be selected based upon geophysical anomalies. Data obtained from the judgmental sampling at this site will be evaluated separately from the probabilistic sampling data, following the procedure presented in Section A.9.1.

Statistical methods that generate site characteristics will be used for the probabilistic sampling data at CAS 03-17-01. The information provided from probabilistic sampling allows for establishing contaminant characteristic concentrations that represent the site as a whole.

A.9.3 Decision II Sampling

To meet the DQI of representativeness for Decision II samples (that Decision II sample locations represent the population of interest as defined in Section A.6.1), judgmental sampling locations at each CAS will be selected based on the outer boundary sample locations where COCs were detected, the CSM, and other field-screening and biasing factors listed in Section A.5.2. In general, sample locations will be arranged in a triangular pattern around the Decision I location or area at distances based on site conditions, process knowledge, and biasing factors. If COCs extend beyond the initial step-outs, Decision II samples will be collected from incremental step-outs. Initial step-outs will be at least as deep as the vertical extent of contamination defined at the Decision I location and the depth of the incremental step-outs will be based on the deepest contamination observed at all locations. A clean sample (i.e., COCs less than FALs) collected from each step-out direction (lateral or vertical) will define extent of contamination in that direction. The number, location, and spacing of step-outs may be modified by the Site Supervisor, as warranted by site conditions.

A.9.4 Group 1: Corrective Action Site 02-09-01, Mud Disposal Area, and Corrective Action Site 09-23-02, U-9y Drilling Mud Disposal Crater

This section discusses the sampling and analysis design for the following CASs located at the northern portion of the Yucca Flat area:

- CAS 02-09-01, Mud Disposal Area
- CAS 09-23-02, U-9y Drilling Mud Disposal Crater

These CASs are combined for discussion of investigation activities because these two CASs are associated with drilling mud disposal in and around craters. Both CASs contain a crater component, which cannot be entered for the investigation, and adjacent area(s) impacted by the release of drilling mud. The sampling approach for both CASs is judgmental, though locations at the wash (e.g., URMA portion) in CAS 09-23-02 may be determined by random, computerized selection if biasing factors are not identified by the radiological and geophysical surveys.

If Decision II sampling is needed at CASs 02-09-01 and/or 09-23-02, vertical step-out samples will be taken at the first depth at which the biasing factor (e.g., stain, elevated radiological readings, or other) appears to no longer be present (i.e., "clean confirmation sample"), up to the extent of the vertical spatial boundary. Lateral step-out samples will be taken at locations where the biasing factor appears to no longer be present and where the lateral migration of contamination would likely be expected (e.g., downgradient), up to the extent of the horizontal spatial boundary. If a spatial boundary is reached, the CSM is shown to be inadequate, or the Site Supervisor determines that extent sampling needs to be re-evaluated, then work will be temporarily suspended, NDEP will be notified, and the investigation strategy will be re-evaluated.

Sample locations depicted on Figures A.9-1 and A.9-2 are proposed, and the actual locations sampled may differ slightly. Each set of sample locations will be established at the most significant biasing factor.

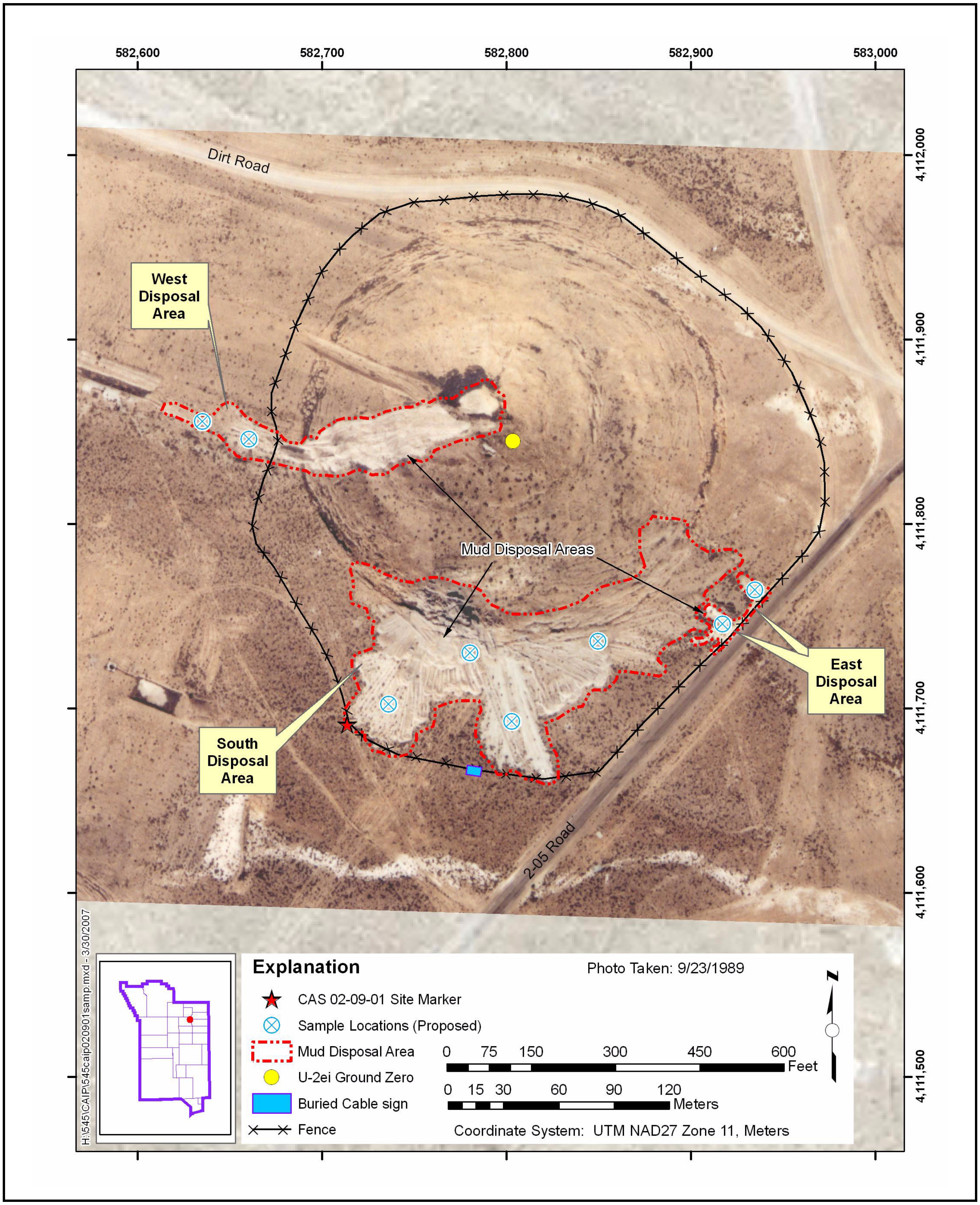

Figure A.9-1
Sample Locations at CAS 02-09-01, Mud Disposal Area

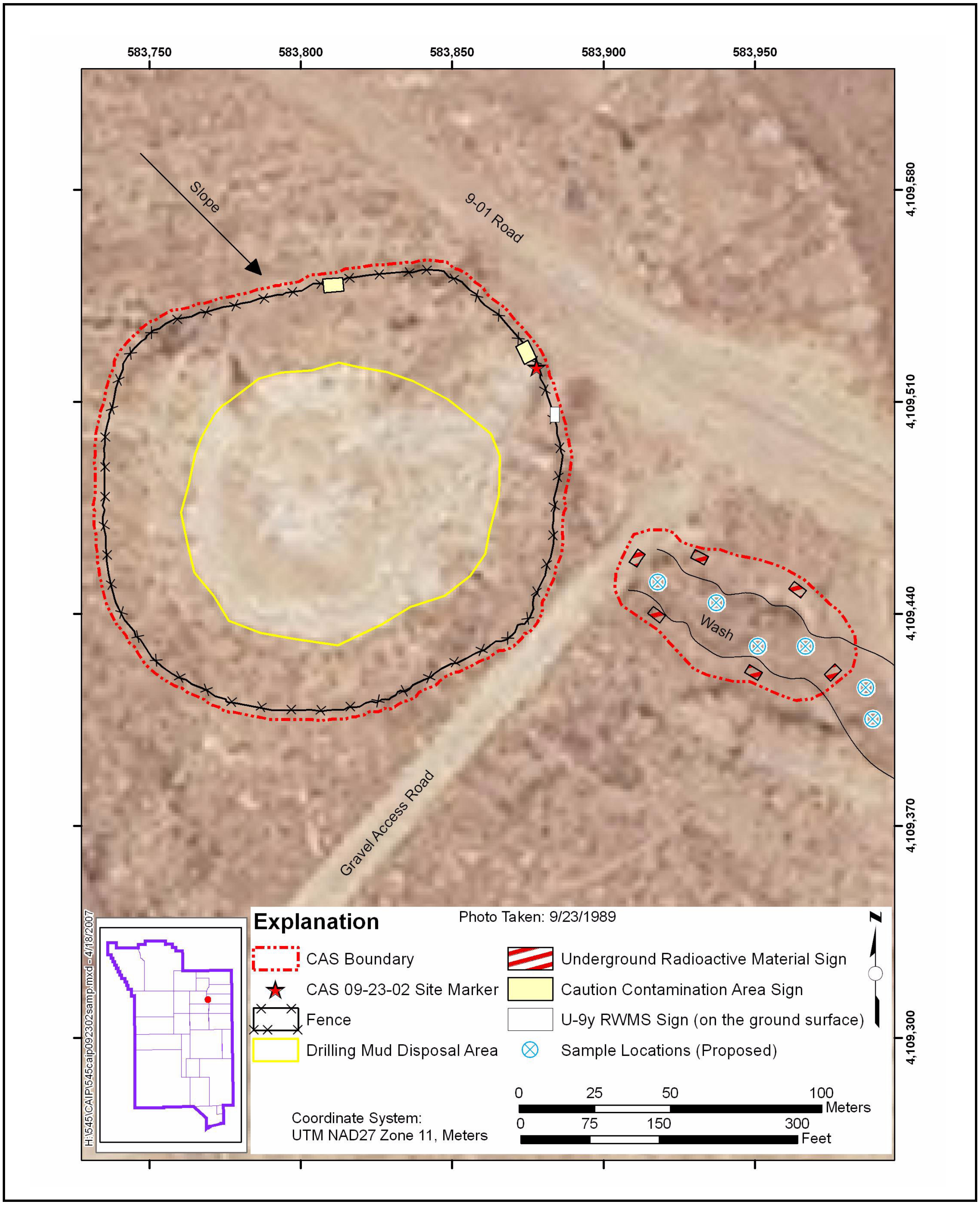

Figure A.9-2
Sample Locations at CAS 09-23-02, U-9y Drilling Mud Disposal Crater

A.9.4.1 Corrective Action Site 02-09-01

The three mud disposal areas adjacent to the crater in CAS 02-09-01 are considered to be mud releases overlaying native soil.

For Decision I sampling at CAS 02-09-01, the three mud disposal areas (Figure A.9-1) will be sampled, at a minimum, as follows:

- The area identified as the east disposal area will be sampled at two locations.
- The area identified as the south disposal area will be sampled at four locations.
- The area identified as the west disposal area will be sampled at two locations.

At each sample location, the surface soil will be sampled at a biased location if the biasing factor is at the surface. If the biasing factor is in the shallow subsurface of the mud (i.e., subsurface geophysical anomaly), a sample will be taken at the depth of the biasing factor and, at the discretion of the Site Supervisor, a surface sample may also be taken. At each location, a sample will also be taken at the drilling mud/native soil interface.

A.9.4.2 Corrective Action Site 09-23-02

The impacted wash adjacent to the crater in CAS 09-23-02 is posted as an URMA, which may be associated with the released mud, waste and debris overlain by the released mud, or other potential wastes.

For Decision I sampling at CAS 09-23-02 (Figure A.9-2), the URMA portion of the wash and the first two sediment traps downgradient from the URMA portion will be sampled, at a minimum, as follows:

- The area delineated by the URMA postings will be sampled at four locations that are either singly excavated or else as part of one or two transects.

- The area that serves as a sediment trap immediately downgradient from the URMA portion of the wash will be sampled in the first two significant areas where migrating sediment is trapped (e.g., sediment traps).

Each sample location in the URMA delineation will be sampled:

- At the surface, if the biasing factor is at the surface (or, at the discretion of the Site Supervisor, at the surface over a subsurface biasing factor);

- At the depth of the biasing factor, if the biasing factor is in the shallow subsurface of the mud (i.e., subsurface geophysical anomaly); and

- At the drilling mud/native soil interface at each location; if the interface cannot be identified, then one sample taken at the estimated interface, and one sample below the estimated interface.

At each sample location in the sediment trap area, because of episodic deposition of sediments, samples will be taken:

- At a biasing factor within the mud; and

- At the mud/native soil interface if a biasing factor is present; if the interface cannot be identified, then one sample taken at the estimated interface, and one sample below the estimated interface.

If a biasing factor is not present, a sample will be taken at 12 inches below the surface.

A.9.5 Group 2: Corrective Action Site 20-19-01, Waste Disposal Site

This section discusses the sampling and analysis design for CAS 20-19-01 located in Area 20.

The crater encompassing CAS 20-19-01 has been determined to be stable and safe to enter. The sampling approach is judgmental, though locations at CAS 20-19-01 may be determined by random, computerized selection if biasing factors are not identified by the radiological survey or by visual observations.

Sampling at CAS 20-19-01 (Figure A.9-3) will focus on soil most likely impacted by any presence of contaminants. For Decision I sampling at CAS 20-19-01, the area comprising the disposal site will be sampled, at a minimum, as follows:

- Ten locations established at biasing factors determined by the radiological survey or by visual observation (e.g., material containing, or possibly impacted by, hazardous and/or radiological constituents).

Sample locations depicted on Figure A.9-3 for CAS 20-19-01 are proposed, and the actual locations sampled may differ slightly. Sample locations will be established at the most significant biasing

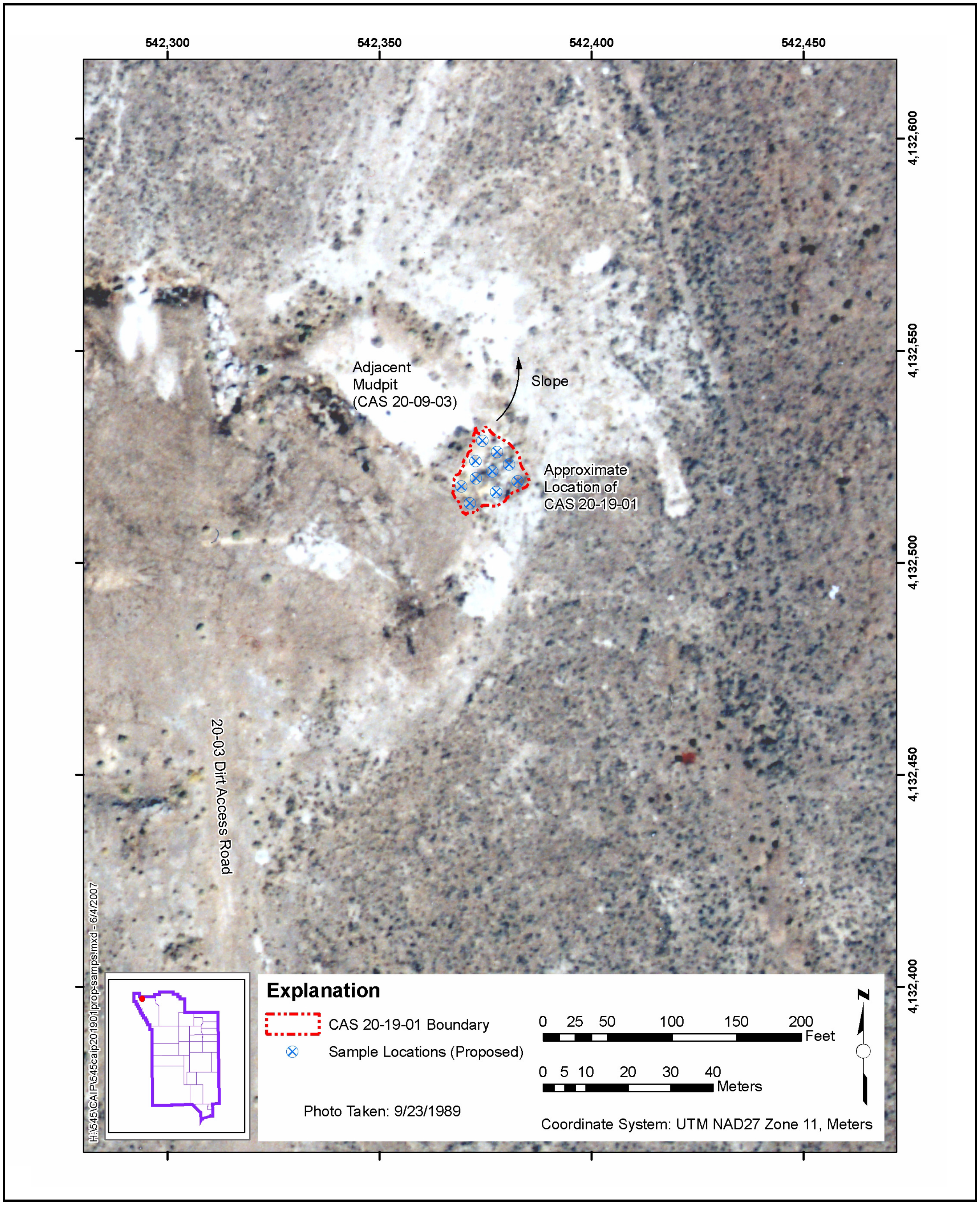

Figure A.9-3
Sample Locations at CAS 20-19-01, Waste Disposal Site

factors if more that 10 biasing factors exist. One sample will be taken of the surface soil impacted by the biasing factor.

If Decision II sampling is needed at CAS 20-19-01, vertical step-out samples will be taken at the first depth at which the biasing factor (e.g., stain, elevated radiological readings, or other) appears to no longer be present (i.e., "clean confirmation sample"), up to the extent of the vertical spatial boundary. Lateral step-out samples will be taken at locations where the biasing factor appears to no longer be present and where the lateral migration of contamination would likely be expected (e.g., downgradient), up to the extent of the horizontal spatial boundary. If a spatial boundary is reached, the CSM is shown to be inadequate, or the Site Supervisor determines that extent sampling needs to be re-evaluated, then work will be temporarily suspended, NDEP will be notified, and the investigation strategy will be re-evaluated.

A.9.6 Group 3: Corrective Action Site 03-17-01, Waste Consolidation Site 3B, and Corrective Action Site 03-99-14, Radioactive Material Disposal Area

This section discusses the sampling and analysis design for the following CASs located in the west-central portion of Area 3:

- CAS 03-17-01, Waste Consolidation Site 3B
- CAS 03-99-14, Radioactive Material Disposal Area

These CASs are combined for discussion of investigation activities because these two CASs are associated with surface and/or buried waste and debris, and do not contain a crater component. Sampling at both CASs will center on soil most likely impacted by any presence of contaminants, however, the approach to each site differs. The overall sampling approach at CAS 03-17-01 is probabilistic, whereas the sampling approach for CAS 03-99-14 is judgmental. Both CASs are comprised of two components: the large, rectangular area and a smaller, round area at CAS 03-17-01; and a berm and a trench at CAS 03-99-14.

If a spatial boundary is reached, the CSM is shown to be inadequate, or the Site Supervisor determines that extent sampling needs to be re-evaluated, then work will be temporarily suspended, NDEP will be notified, and the investigation strategy will be re-evaluated.

A.9.6.1 Corrective Action Site 03-17-01

For Decision I sampling at CAS 03-17-01 (Figure A.9-4), the two components will be sampled, at a minimum, as follows:

- The large rectangular area will be sampled at 12 surface locations determined by VSP, as the probabilistic portion of the investigation.
- The small circular area will also be sampled at 12 surface locations determined by VSP, as the probabilistic portion of the investigation.
- For the two component areas together, five locations that are at the most prominent geophysical anomalies will be sampled (judgmental) using grab or auger techniques; these locations will not include any rodent trap that has been installed in the area.

The five judgmental sample locations depicted on Figure A.9-4 are proposed, and the actual locations sampled may differ slightly. The probabilistic sample locations depicted in Figure A.9-4 represent those actual sample locations predetermined by the VSP software (PNNL, 2005).

Sampling for Decision II purposes at CAS 03-17-01 will consist of:

- In the event a COC is identified through the judgmental portion of the sampling, but not by the probabilistic portion, individual locations (judgmental and probabilistic) within that component (circular or rectangular area) will be used to define a distinct subarea for contaminant bounding.
- In the event a COC is identified through the probabilistic portion of the sampling, lateral extent will be defined by collecting samples outside the component boundaries. Vertical extent will be defined by collecting depth samples from the two locations containing the highest COC concentrations.

A.9.6.2 Corrective Action Site 03-99-14

For Decision I sampling at CAS 03-99-14 (Figure A.9-5), the two components will be sampled, at a minimum, as follows:

- Four transects will be established, with one generally in the western quarter of the CAS, one generally in the eastern quarter of the CAS, and the other two across the middle half of the CAS. Each transect will be established so that either a significant biasing factor exists at a location on the berm or in the trench, or, if significant biasing factors are not identified, approximately equal distance apart.

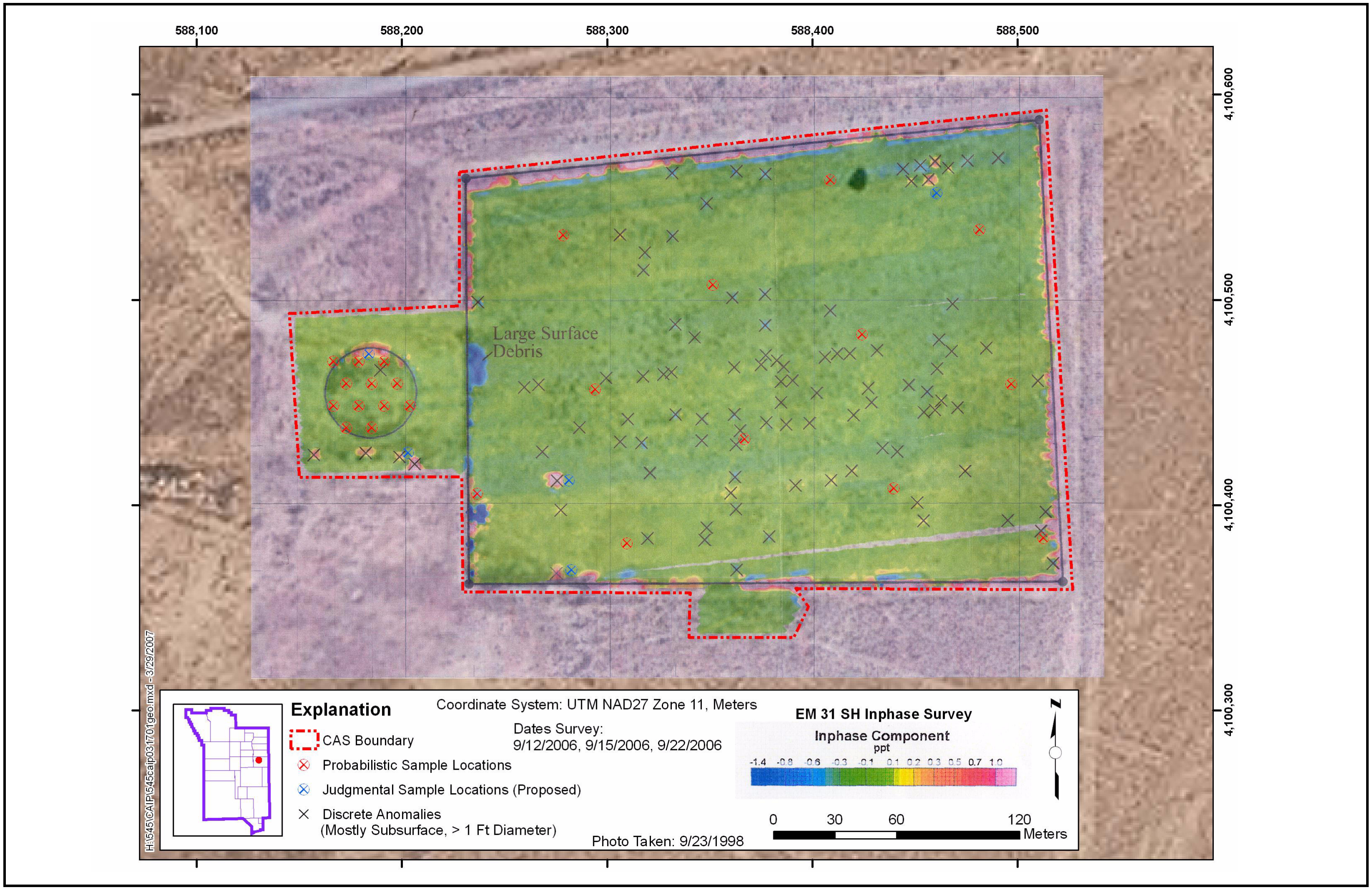

Figure A.9-4
Sample Locations at CAS 03-17-01, Waste Consolidation Site 3B

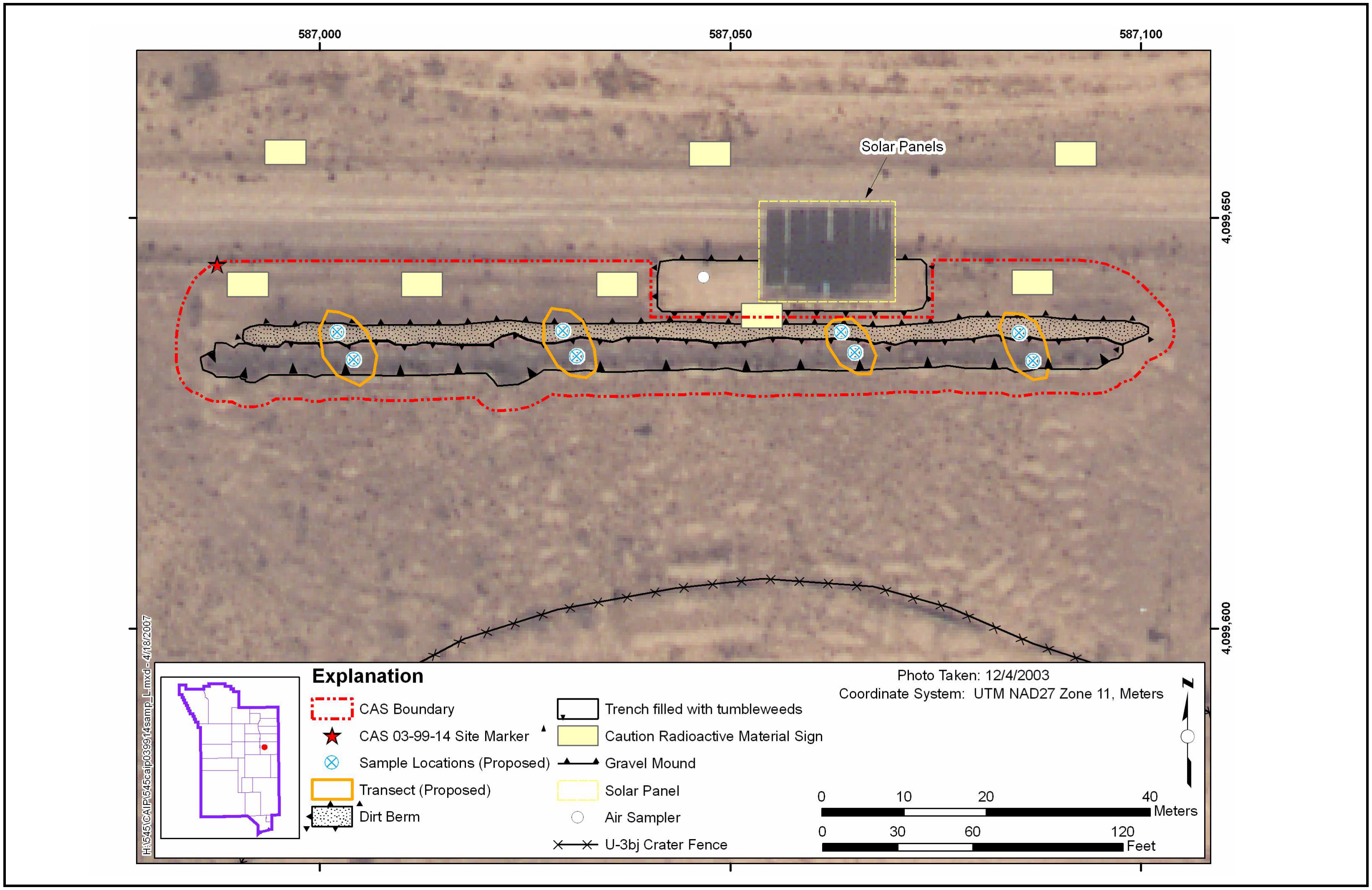

Figure A.9-5
Sample Locations at CAS 03-99-14, Radioactive Material Disposal Area

- Across each transect, one sample location each will be established on the berm and in the trench, at the most significant biasing factors. If biasing factors do not exist, sample locations will be selected randomly (i.e., computer-generated random locations within the transect).

The transects and sample locations depicted on Figure A.9-5, are proposed, and the actual locations sampled may differ slightly.

Because CAS 03-99-14 is in an area impacted by nearby atmospheric testing (Figure A.2-19), several samples will be collected from locations around the site to determine radiological activities that have originated from sources other than the CAS.

For Decision II sampling at CAS 03-99-14, vertical step-out samples will be taken at the first depth at which the biasing factor (e.g., stain, elevated radiological readings, or other) appears to no longer be present (i.e., "clean confirmation sample"), up to the extent of the vertical spatial boundary. Lateral step-out samples will be taken at locations where the biasing factor appears to no longer be present and where the lateral migration of contamination would likely be expected (e.g., downgradient), up to the extent of the horizontal spatial boundary.

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Appendix B

Project Organization

B.1.0 Project Organization

The NNSA/NSO Federal Sub-Project Director is Kevin J. Cabble. He can be contacted at (702) 295-5000. The NNSA/NSO Task Manager is Peter A. Sanders. He can be contacted at (702) 295-1037.

The identification of the project Health and Safety Officer and the Quality Assurance Officer can be found in the appropriate plan. However, personnel are subject to change and it is suggested that the NNSA/NSO Environmental Restoration Federal Project Director be contacted for further information. The Task Manager will be identified in the FFACO Monthly Activity Report before the start of field activities.

Appendix C

Determination of the Number and Location of Random Samples

C.1.0 Probabilistic Sampling Information

C.1.1 Initial Sample Size and Sample Locations for CAS 03-17-01

The initial sample size was established during the DQO meeting at 12 locations each for the circular and rectangular areas comprising CAS 03-17-01. A summary of the sampling design, including the formula for recalculating the number of sample locations based upon the analytical results, is listed in Table C.1-1.

Table C.1-1
Summary of Sampling Design, CAS 03-17-01

Primary Objective of Design	Compare a site average to a fixed threshold
Type of sampling design	Nonparametric
Sample placement (location) in the field	Systematic with a random start location
Working (null) hypothesis	The average value at the site exceeds the threshold
Formula for calculating number of sampling locations	Sign test - MARSSIM version
Grid pattern	Triangular

The coordinates for each of the initial 24 sample locations were generated on February 6, 2007, from VSP and are listed in Table C.1-2 (PNNL, 2005).

Table C.1-2
Calculated Field Sampling Location Coordinates, CAS 03-17-01

Easting Coordinate	Northing Coordinate
588236.9824	4100405.5349
588309.8154	4100381.3606
588294.3345	4100456.5230
588367.1675	4100432.3486
588440.0004	4100408.1743
588512.8334	4100383.9999
588278.8536	4100531.6853
588351.6866	4100507.5110
588424.5196	4100483.3366
588497.3525	4100459.1623
588409.0387	4100558.4990
588481.8716	4100534.3246
588173.0733	4100437.8177
588185.4820	4100437.8177
588166.8690	4100448.5640
588179.2777	4100448.5640
588191.6864	4100448.5640
588204.0951	4100448.5640
588173.0733	4100459.3102
588185.4820	4100459.3102
588197.8907	4100459.3102
588166.8690	4100470.0565
588179.2777	4100470.0565
588191.6864	4100470.0565

Note: Sample location coordinates calculated by Visual Sample Plan software (PNNL, 2005).

C.2.0 References

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Appendix D

Nevada Division of Environmental Protection Comment Responses

(2 Pages)

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

1. Document Title/Number: Draft Draft Corrective Action Investigation Plan for Corrective Action Unit 545: Dumps, Waste Disposal Sites, and Buried Radioactive Materials, Nevada Test Site, Nevada	**2. Document Date:** 04/23/2007
3. Revision Number: 0	**4. Originator/Organization:** Stoller-Navarro
5. Responsible NNSA/NV ERP Project Manager: Kevin J. Cabble	**6. Date Comments Due:** 05/23/2007
7. Review Criteria: Full	
8. Reviewer/Organization/Phone No: Don Elle and Denny Nicodemus, NDEP, 486-2850	**9. Reviewer's Signature:**

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1.) Section 1.1.2 Data Quality Objective Summary, Page 4	Mandatory	A statement is given and then referred to as a question in the first complete sentence on page 4. Suggest changing "To address this question..." to "To address this problem (or insufficiency)..."	The text in Section 1.1.2 has been changed to agree with the wording "The DQO problem statement ...". The sentence beginning with "To address this question ..." now states "To address this problem ..."	Yes
2.) Section 2.1.1 Yucca Flat, Page 9	Mandatory	Incorrect use of a reference at the top of the page "...1,821 ft bgs in 1996 (USGS and DOE, 2006)." The original document used in 1996 to determine the depth should be used. If the USGS and DOE reaffirmed the depth to water table in 2006 then "in 1996" should be removed. Please correct.	The text has been clarified to better reflect how the information is presented at the USGS web site. The web site presents a graph of measurements at Water Well U-2gg PS E3A. The last measurement taken was in 1996. In the CAIP, the standard practice is to list the date that the information in the reference was accessed, which was on August 1, 2006. To reduce the confusion from the wording of the sentence, it now reads "The water level in this well, last measured in 1996, was 1,821 ft bgs (USGS and DOE, 2006)."	Yes

3.) Section 2.2.2.1 Corrective Action Site 03-23-02 Waste Disposal Site, Page 11	Mandatory	Statement is given that lists this CAS as a high-risk beryllium legacy site and references two sources (SAIC, 2004; BN, 2004). However, on page A-18, second paragraph, it is stated as "evidence was not identified that would confirm the designation of this site as a high-risk beryllium legacy site (SAIC, 2004; BN, 2004).: These two statements seem to contradict the use of the same references, please clarify. Along the same lines, can any sampling be done at CAS 03-23-02 to verify if the site should be listed as a beryllium legacy site? If subsidence is possibility, please include.	To address the discrepency between the listing of the site as a high-risk beryllium legacy site and no evidence found that beryllium was present at the site, the following text has been reworded: in Section 2.2.2.1, page 11, second paragraph, the second sentence which read "The reason for this designation was not identified." has been replaced with "The document that originally identified the site as a beryllium legacy site (SAIC, 2003) did not provide evidence from samples taken at the site or of operations at the site that beryllium was present. Evidence that beryllium was present at the site was also not identified in any other source reviewed during the site assessment". In Section A.2.2.1 (Operational History), second paragraph on page A-18, the first sentence which reads "Evidence was not identified that would confirm the designation of the site as a high-risk beryllium legacy site (SAIC, 2004; BN, 2004)." has been changed to match the first sentence and the two new sentences of the second paragraph in Section 2.2.2.1, " Corrective Action Site 03-23-02 is listed as a high-risk beryllium legacy site (SAIC, 2003; BN, 2004). The document that originally identified the site as a beryllium legacy site (SAIC, 2003) did not provide evidence from samples taken at the site or of operations at the site that beryllium was present. Evidence that beryllium was present at the site was also not identified in any other source reviewed during the site assessment." To address the issue of possible sampling at the site, the following sentence was added to the document as a new paragraph at the end of Section 2.2.2.1: "Because the site consists of an unsubsided crater, and the site has been designated as "possible" for future subsidence phenomena, sampling cannot be conducted at CAS 03-23-02 safely (LANL, date unknown)."	Yes

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